PERÚ Ministerio de la Producción | Instituto del Mar del Perú IMARPE

AFIRTAM

INSTITUTO DEL MAR DEL PERU CIENCIA Y TECNOLOGIA

Una visión a la evaluación de stocks del Perico/Dorado (*Coryphaena hippurus*) a partir de la información de la pesquería en Perú

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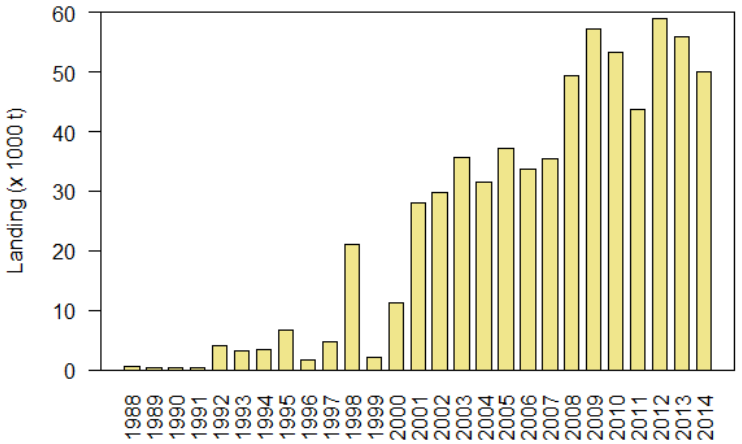
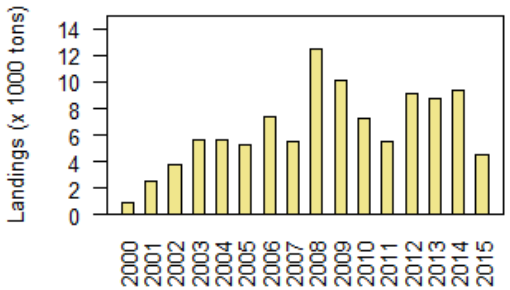
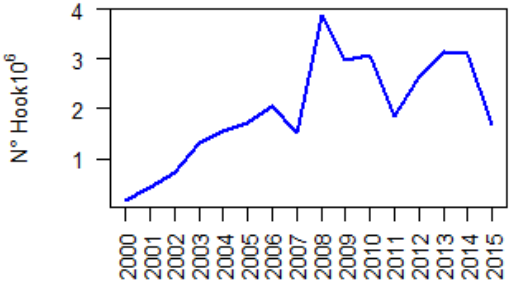
2ª Reunión Técnica sobre el Dorado.
27-29 de octubre de 2015 - Lima, Perú

Data description

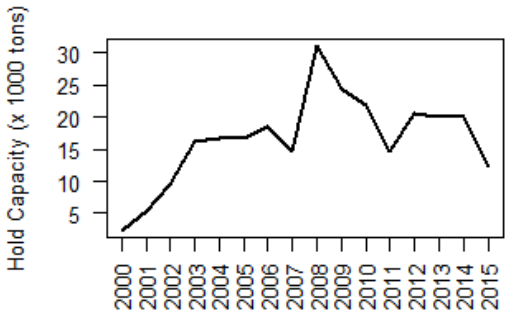
- FAO - PRODUCE:
  - Desembarques Oficiales: 1988 - 2014

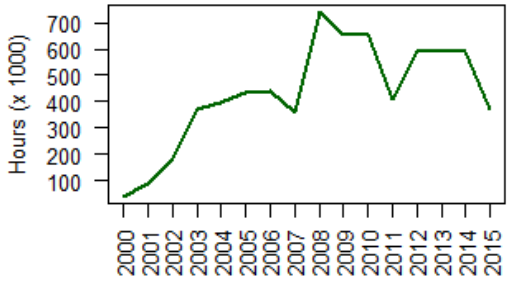






- IMARPE:
  - Unidad de pesca artesanal.
    - Desembarques, esfuerzo.





Cuando sólo se disponen de datos de captura y esfuerzo, los modelos de biomasa dinámica son la herramienta primaria de evaluación en muchas pesquerías (Hilborn y Walters, 1992).

Parámetros Poblacionales

- A simple method for estimating MSY from catch and resilence (Martell & Froese (2012))

Inputs:

✓ Serie de tiempo de capturas (desembarques): FAO - PRODUCE.

✓ Prior de *r* y *k* (rangos) y posibles rangos del tamaño relativo del stock en el inicio y el final de la serie de tiempo de capturas.

✓ Clasificación de Resiliencia: FishBase (Froese *et al*. 2000).

	Catch/Max Catch	*B/K*
First year	<0.5	0.5 - 0.9
	≥ 0.5	0.3 - 0.6
Last year	> 0.5	0.3 - 0.7
	≤ 0.5	0.01 - 0.4

Tomado de Froese *et al.* (2012)

Parámetros Poblacionales

- A simple method for estimating MSY from catch and resilence (Martell & Froese, 2012)

Método:

✓Modelo de producción de Schaefer para calcular la biomasa anual a partir del set de parámetros *r* y *k.*

$$B_{(t+1)} = B_t + r * B_t * \left(1 - {B_t}/{k}\right) - C_t$$

✓Pares *r-k* : a partir de una distribución uniforme. (geometric means).

$$p(\log(r)) \sim uniform(\log(r_l), \log(r_u))$$

$$p(\log(k)) \sim uniform(\log(k_l), \log(k_u))$$

✓*MSY* es calculado a partir de los valores de *r* y *k*

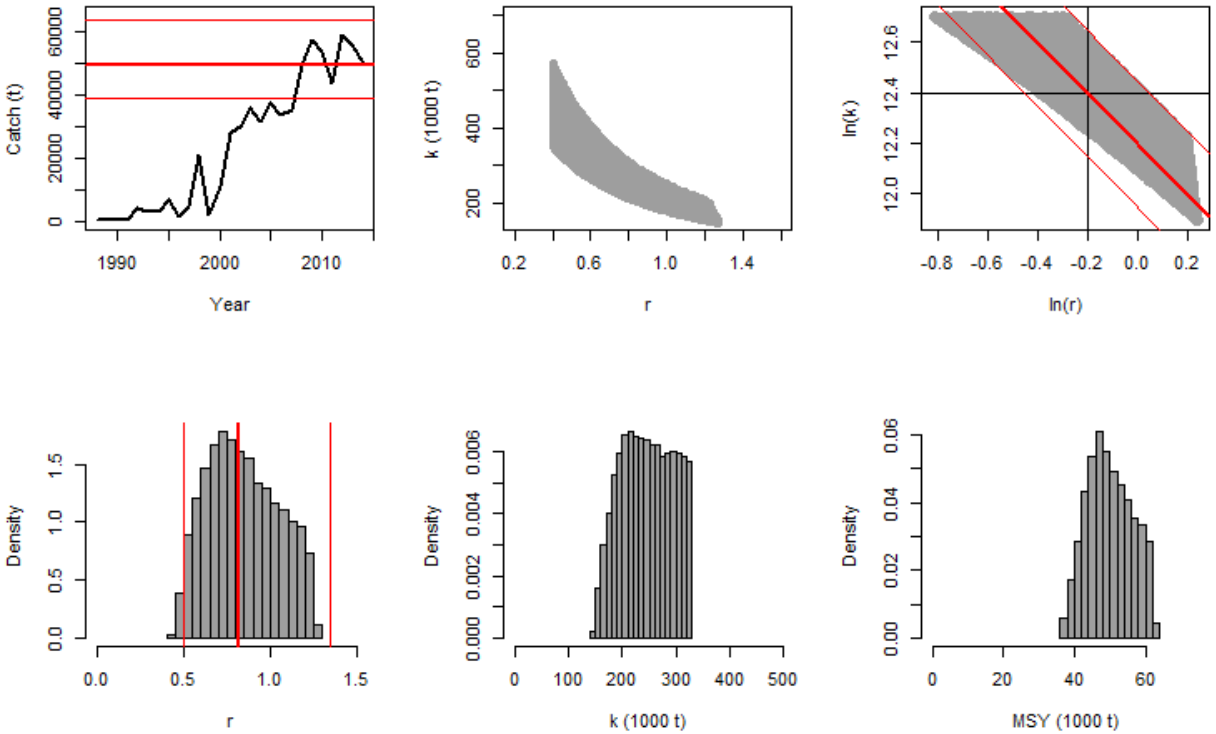
Resilence	High	Medium	Low	Very Low
r(year^{-1})	0.6-1.5	0.2 - 1	0.05 - 0.5	0.015 - 0.1

Tomado de: Martell & Froese (2012)

Parámetros poblacionales

- A simple method for estimating MSY from catch and resilence (Martell & Froese, 2012)

Parameters	geom. Mean	± 2 SD
r(year^{-1})	0.819	0.5 - 1.34
k (t)	241 973	162 484 - 360 349
B_{MSY} (t)	120 986	81 242 - 180 175
MSY (t)	49 563	38 590 - 63 656



Índice de abundancia

Estandarización de la CPUE

✓ Beverton y Holt (1957)

Seleccionar una “embarcación estándar” y determinar el poder relativo de pesca de todas las otras embarcaciones.

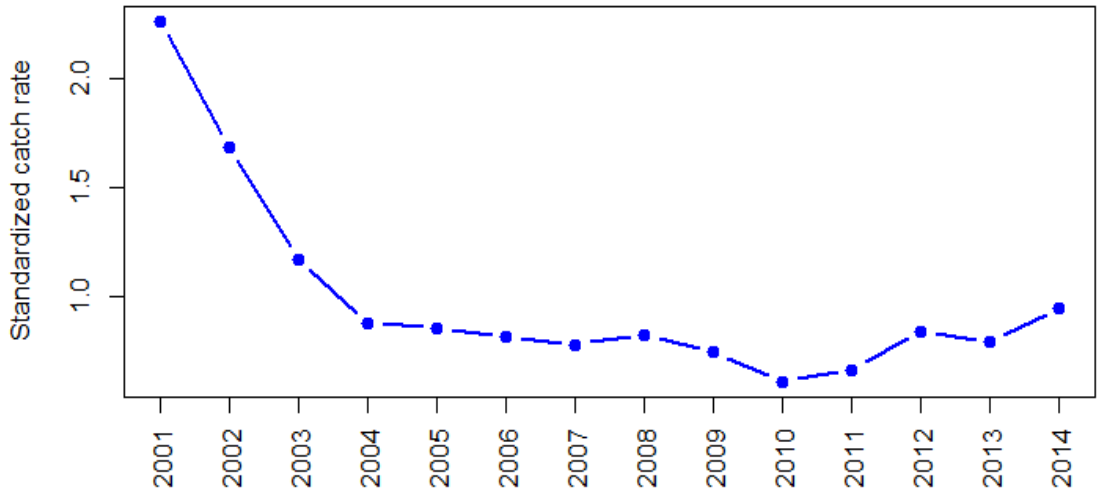
- Datos (IMARPE):

- Desembarques

- Esfuerzo: Capacidad de bodega.

$$RFP_i = \frac{C_i / E_i}{C_s / E_S}$$

$$I_t = \frac{\sum_t C_{t,i}}{\sum_i (RFP_i E_{t,i})}$$



Índice de abundancia

✓ GAM (Maunder & Punt, 2004)

Remover los factores que influencian en la CPUE y **generar un índice de abundancia relativa por año (o periodos)**.

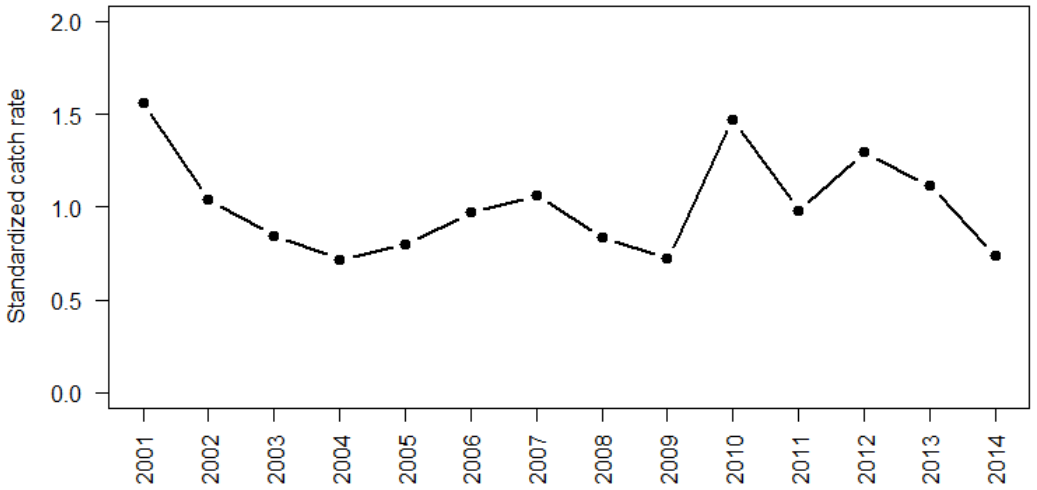
- Data (IMARPE):

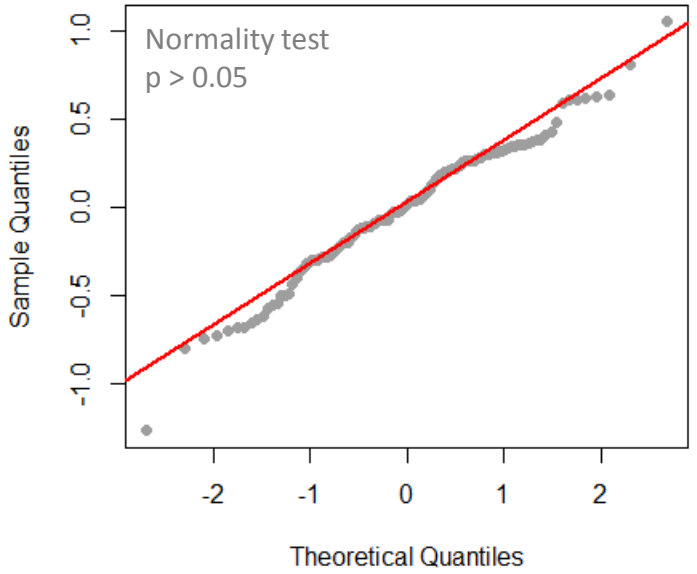
- Desembarques (mensuales - viaje)

- Esfuerzo: Capacidad de bodega, N° anzuelos, horas efectivas*

- Variables ambientales (Indice de anomalía : **Niño1+2** SST).

$$GAM: \log(CPUE) \sim Year + season + s(niño12)$$





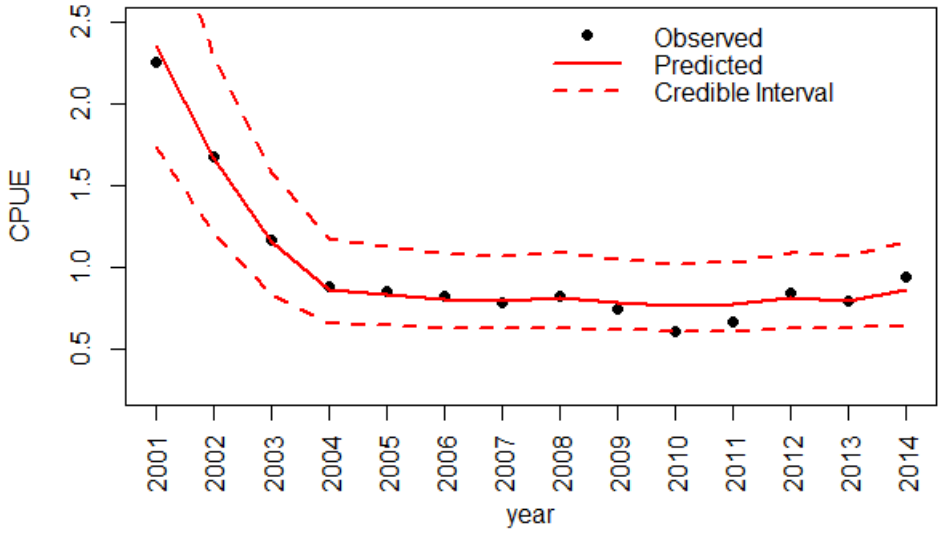
Evaluación de Stocks

✓ BUGS in Bayesian stock assessment (Meyer & Millar, 1999)

Input:

- Desembarques (FAO 2001 - 2014)
- CPUE
- Priors (r, K, q, σ^2, τ^2)

R + JAGS (Just Another Gibbs Sampler)



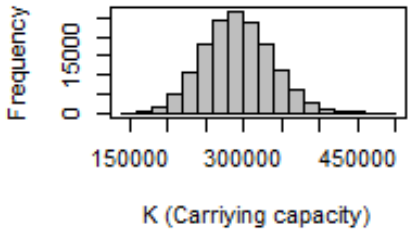

```
#model in BUGS code
sink("surplusProduction.txt")
cat("
    model
    {
    # priors K
    K ~ dlnorm(15.92, 10)I(10000, 500000)

    #priors r
    r ~ dnorm(0.6, 500)I(0.01, 1.2)

    #prior q
    iq ~ dgamma(0.001, 0.001)#I(0.5, 200) #Non informative prior
    q <- 1/iq

    #priors isigma itau
    isigma2 ~ dunif(0.02, 400)       #According to Gelman
    sigma2 <- 1/isigma2

    itau2 ~ dgamma(1.7, 0.01)
    tau2 <- 1/itau2

    #time step [1] conditions
    Pmed[1] <- 0
    P[1] ~ dlnorm(Pmed[1], isigma2)T(0.05, 1.6)

    #time steps of model
    for(t in 2:N){
    Pmed[t] <- log(max(P[t-1] + (r*P[t-1])*(1-P[t-1]) - C[t-1]/K, 0.001))
    P[t] ~ dlnorm(Pmed[t], isigma2)T(0.05, 1.5)
    }

    #Sampling Distribution
    for (t in 1:N)
    {
    Imed[t] <- log(q*K*P[t])
    I[t] ~ dlnorm(Imed[t], itau2)

    #posterior predictions
    index[t] <- log(q*K*P[t])
    I.new[t] ~ dlnorm(index[t], itau2)
    }

    #additional parameters and preditions
    MSP <-  r*K/4
    EMSP <-  r/(2*q)
    BMSY <- K/2
    P2015 <-  P[N] + r*P[N]*(1-P[N]) - C[N]/K
    B2015 <-  P2015*K
    }
```

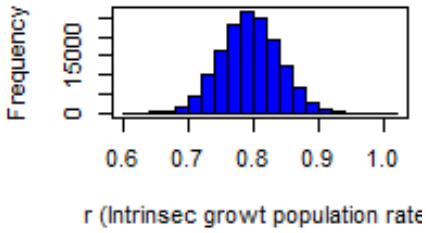
Evaluación de stocks

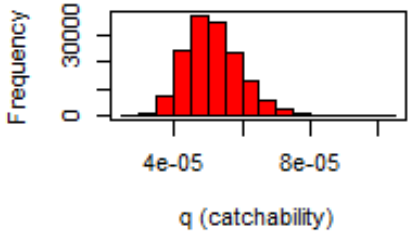
- ✓ BUGS Bayesian Stock Assessment (Meyer & Millar, 1999)

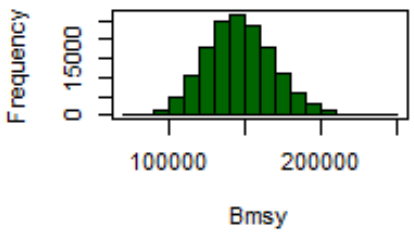
```
Inference for Bugs model at "surplusProduction.txt", fit using jags,
 3 chains, each with 5e+05 iterations (first 1000 discarded), n.thin = 10
 n.sims = 149700 iterations saved
            mu.vect    sd.vect       2.5%        25%        50%        75%      97.5%  Rhat
BMSY      146349.154 22332.620 104952.278 130831.286 145518.678 161063.435 192412.996 1.001
I.new[1]       2.378     0.389      1.733      2.123      2.338      2.584      3.267 1.001
I.new[2]       1.689     0.266      1.218      1.514      1.669      1.840      2.278 1.001
I.new[3]       1.170     0.183      0.841      1.050      1.158      1.276      1.568 1.001
I.new[4]       0.868     0.126      0.652      0.783      0.857      0.940      1.149 1.001
I.new[5]       0.840     0.119      0.638      0.760      0.830      0.907      1.106 1.001
I.new[6]       0.814     0.111      0.626      0.741      0.804      0.876      1.062 1.001
I.new[7]       0.802     0.108      0.621      0.730      0.791      0.862      1.047 1.001
I.new[8]       0.819     0.113      0.628      0.744      0.808      0.881      1.072 1.001
I.new[9]       0.793     0.107      0.616      0.722      0.782      0.850      1.034 1.001
I.new[10]      0.770     0.101      0.602      0.702      0.759      0.824      0.999 1.001
I.new[11]      0.776     0.103      0.605      0.707      0.765      0.832      1.009 1.001
I.new[12]      0.824     0.114      0.631      0.748      0.813      0.888      1.078 1.001
I.new[13]      0.806     0.109      0.624      0.733      0.795      0.866      1.052 1.001
I.new[14]      0.880     0.129      0.653      0.792      0.871      0.957      1.160 1.001
K         292698.307 44665.239 209904.557 261662.573 291037.357 322126.870 384825.993 1.001
MSP        58052.398  9220.042  41074.776  51626.099  57663.705  64078.980  77092.587 1.001
q              0.000     0.000      0.000      0.000      0.000      0.000      0.000 1.001
r              0.794     0.044      0.707      0.764      0.794      0.824      0.881 1.001
sigma2         0.460     0.191      0.208      0.328      0.422      0.548      0.935 1.001
tau2           0.013     0.008      0.004      0.008      0.011      0.016      0.032 1.001
deviance     -23.969     6.166    -36.165    -27.845    -24.040    -20.159    -11.426 1.001

For each parameter, n.eff is a crude measure of effective sample size,
and Rhat is the potential scale reduction factor (at convergence, Rhat=1).

DIC info (using the rule, pD = var(deviance)/2)
pD = 19.0 and DIC = -5.0
DIC is an estimate of expected predictive error (lower deviance is better).
```

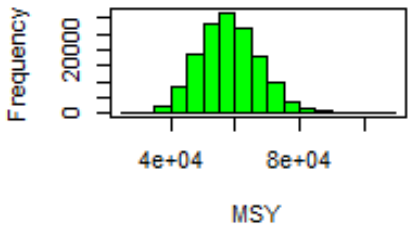
Parameters	Median	Credible Intervals
r(year^{-1})	0.794	0.707 - 0.881
k (t)	291 037	209 905 - 384 825
MSY (t)	58 052	41 074 - 77 093
B_{MSY} (t)	145 519	104 952 - 192 413
q (x10^{-5})	5.08	3.81 - 7.06

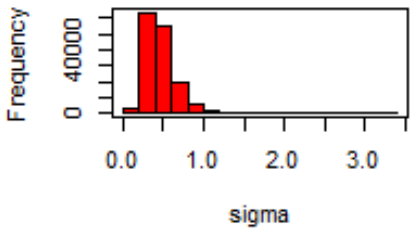




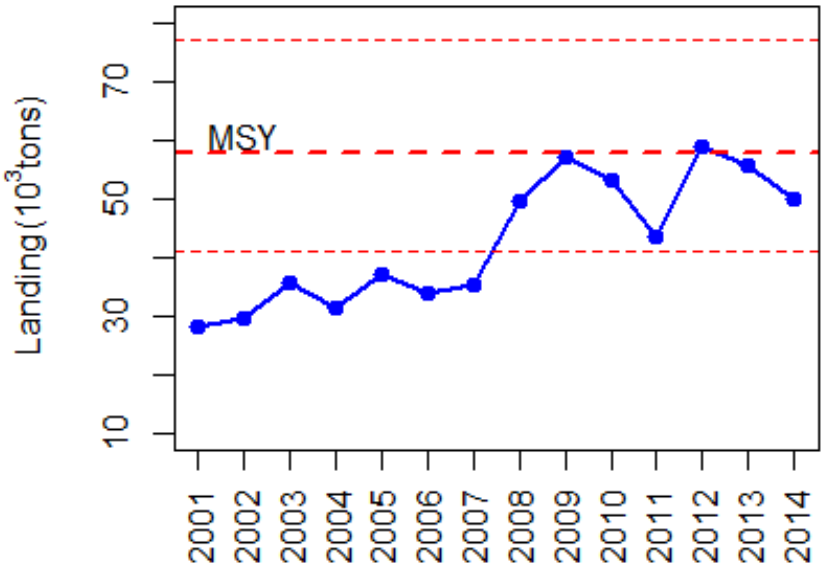


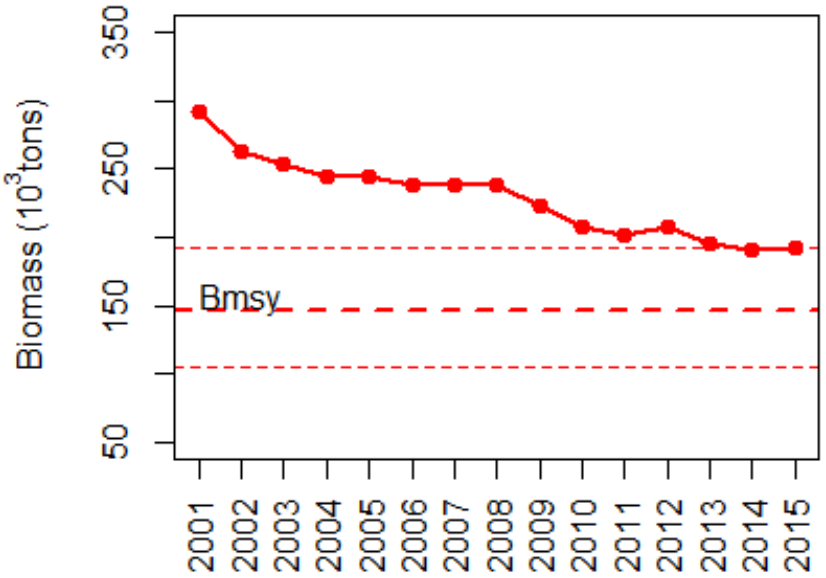






Evaluación de stocks





Github https://github.com/imarpe

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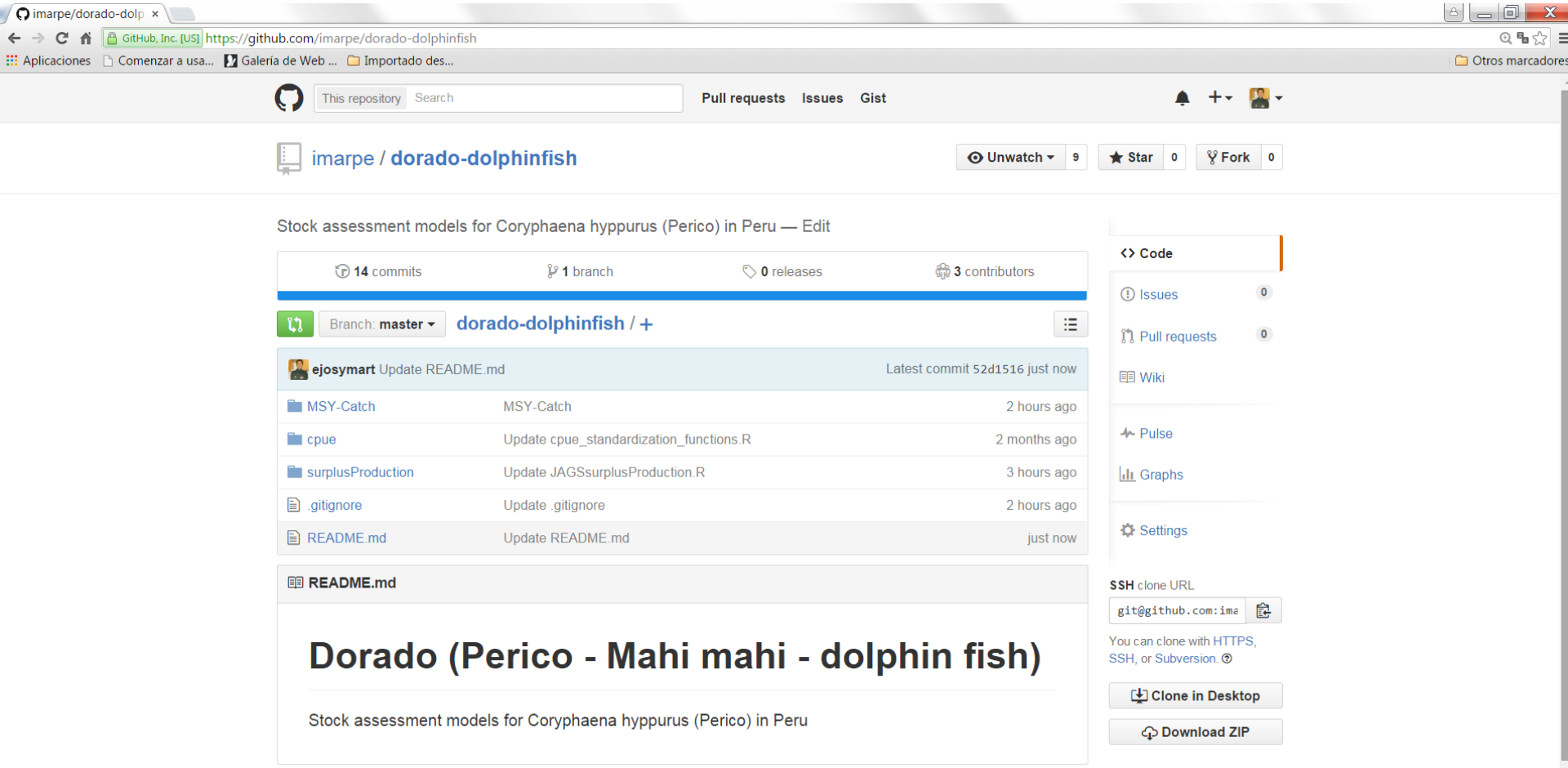

Perspectivas

✓ Por hacer:

- Integrating the standardization of catch per unit of effort into stock assessment models (Maunder, 2001).

- Resolución mensual.

✓ Todos están invitados a contribuir (mejorar) los códigos (open source).

✓ Aplicar los códigos desarrollados a la información de otros países (p.ej: MSY - Catch).

GRACIAS

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