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

Edgar Josymar Torrejón – Magallanes⁽¹⁾

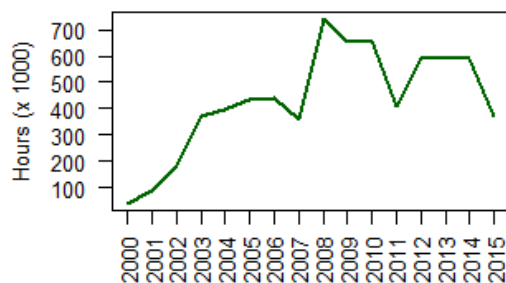
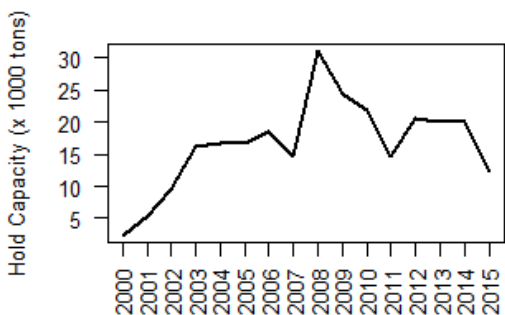
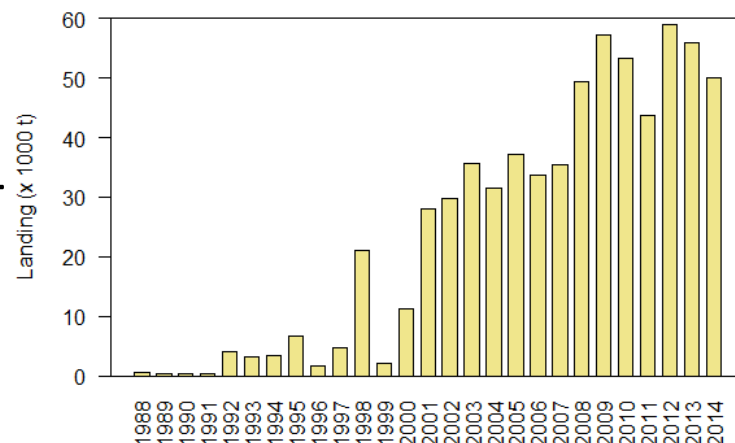
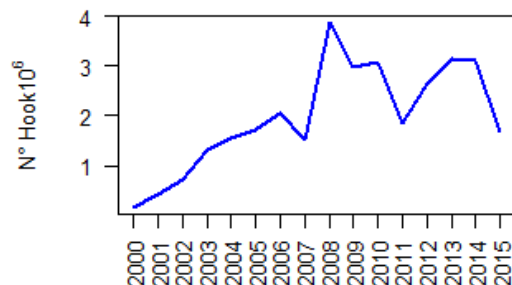
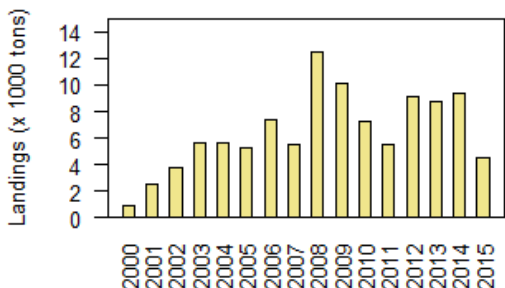
Ricardo Oliveros - Ramos

(1) Instituto del Mar del Perú (IMARPE)

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 resilience (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).

| | <i>Catch/Max Catch</i> | <i>B/K</i> |
|------------|------------------------|------------|
| 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 |

Parámetros Poblacionales

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

Método:

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

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

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

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

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

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

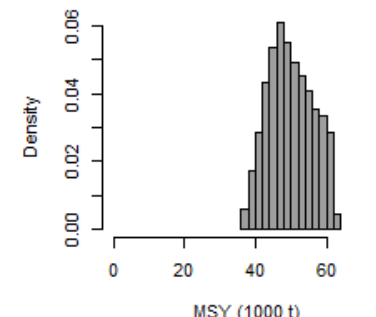
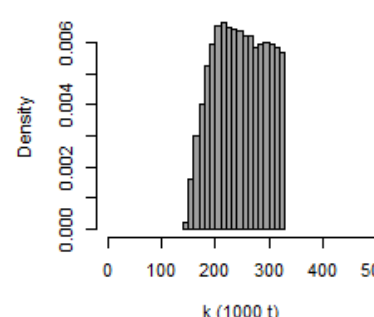
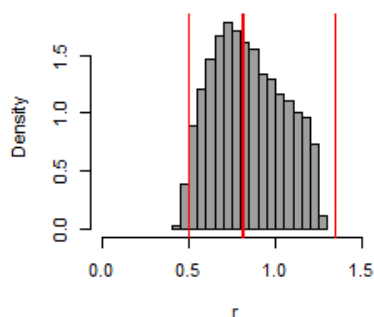
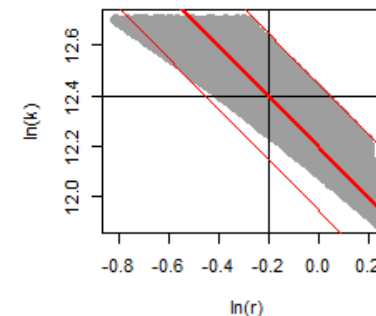
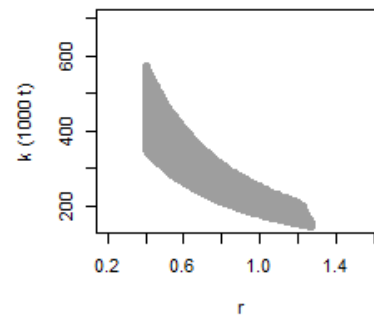
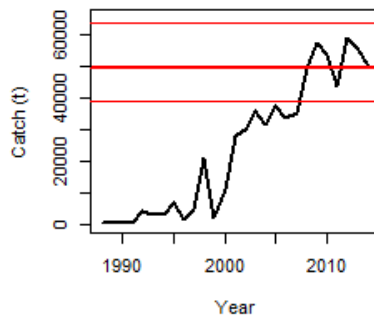
| Resilience | High | Medium | Low | Very Low |
|-----------------------|---------|---------|------------|-------------|
| $r(\text{year}^{-1})$ | 0.6-1.5 | 0.2 - 1 | 0.05 - 0.5 | 0.015 - 0.1 |

Tomado de: Martell & Froese (2012)

Parámetros poblacionales

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

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



Índice de abundancia

Estandarización de la CPUE

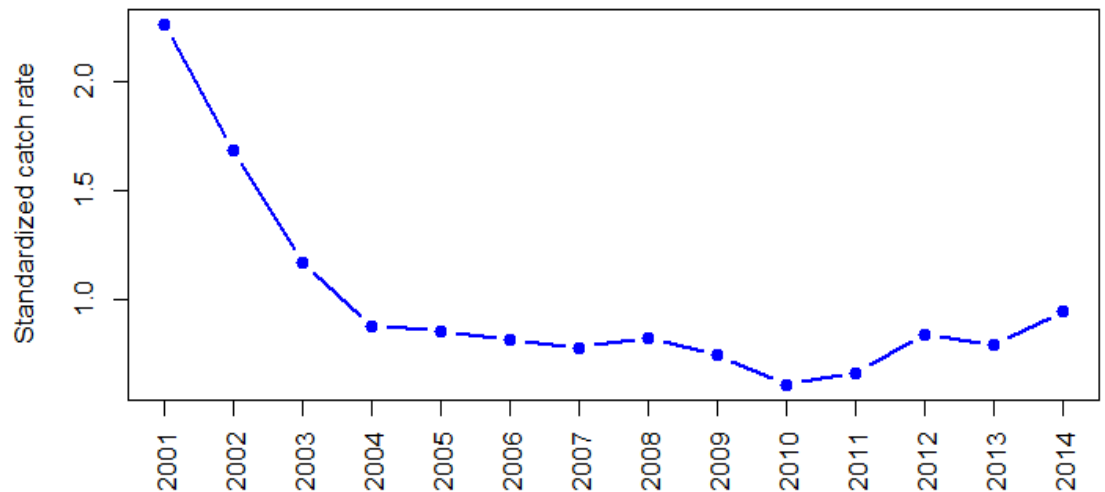
✓ Beverton y Holt (1957)

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

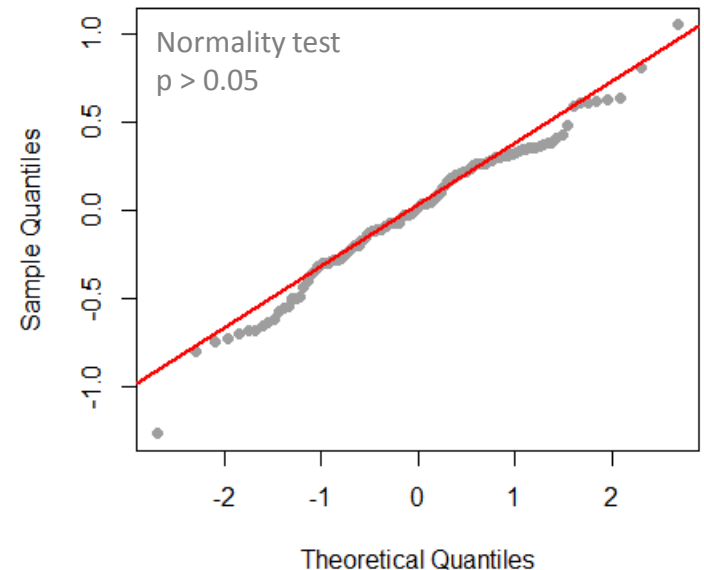
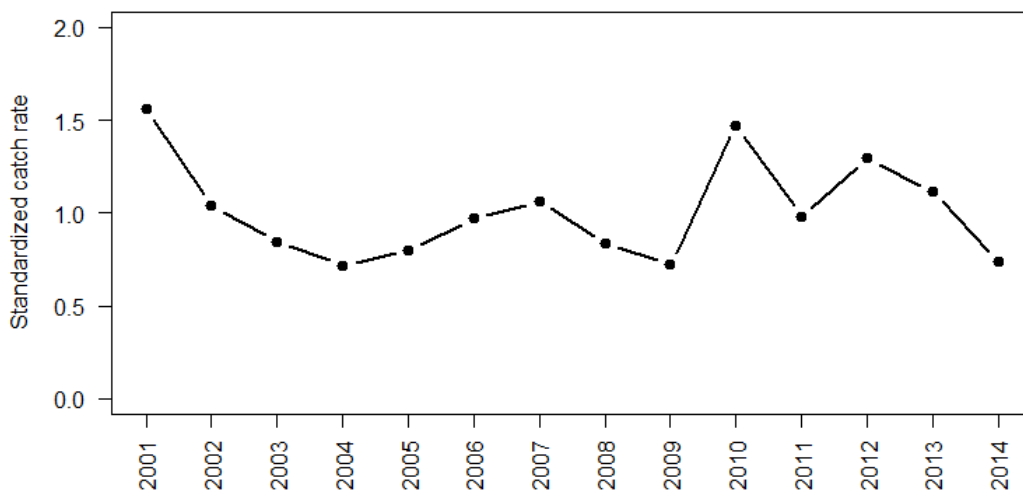
✓ GAM (Maunder & Punt, 2004)

Remover los factores que influyen 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: $\log(CPUE) \sim Year + season + s(niño12)$



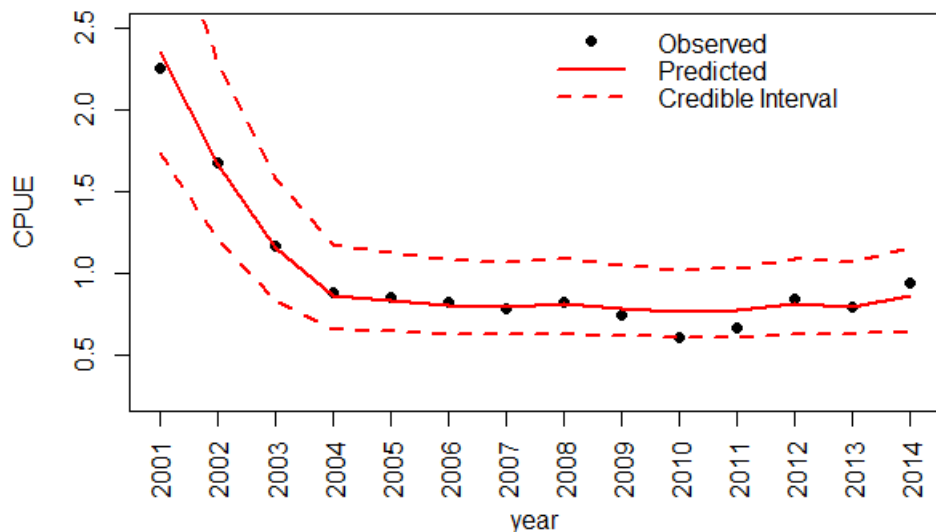
Evaluación de Stocks

- ✓ 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)
  {
    lmed[t] <- log(q*K*P[t])
    I[t] ~ dlnorm(lmed[t], itau2)
  }

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

#additional parameters and predictions
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

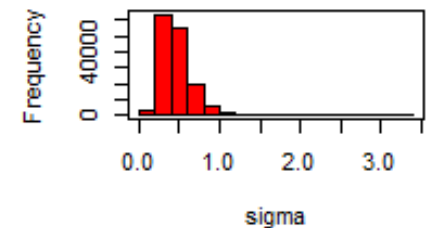
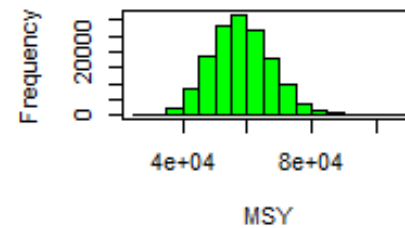
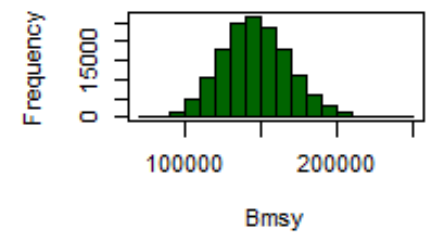
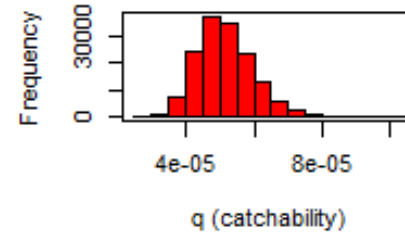
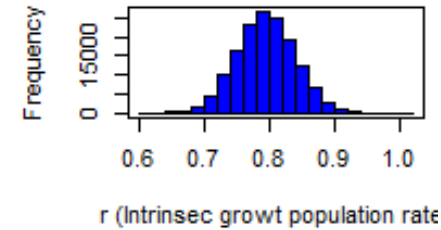
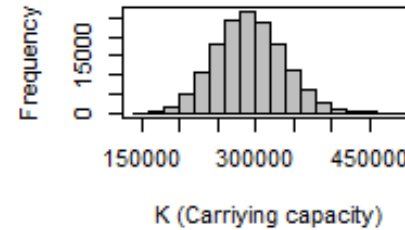
✓ BUGS Bayesian Stock Assessment (Meyer & Millar, 1999)

```
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      1.009  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

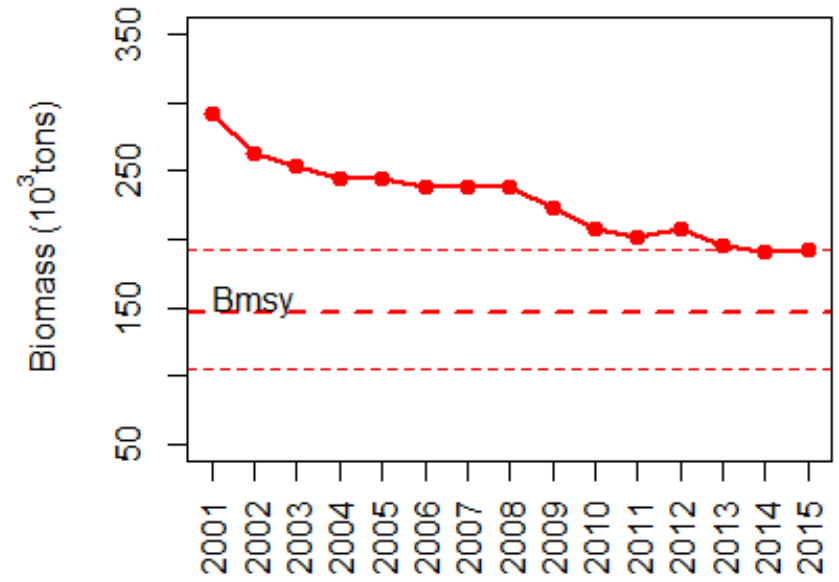
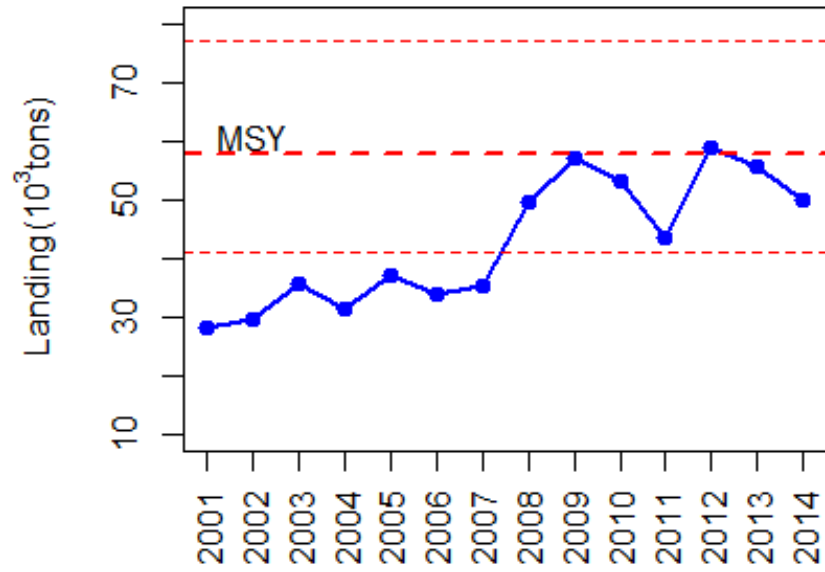
For each parameter, n.eff is a crude measure of effective sample size,
and Rhat is the potential scale reduction factor (at convergence, Rhat=1).

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 |
|-----------------------|---------|--------------------|
| $r(\text{year}^{-1})$ | 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>

Instituto del Mar del Perú

Callao, Perú <http://www.imarpe.gob.pe>

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- dorado-dolphinfish** R ★ 0 🗑 0
Stock assessment models for *Coryphaena hyppurus* (Perico) in Peru
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Validation test for JJM multistock version, Comparison with JJM 2014 for 2014's assessment
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People 13 >

Github

<https://github.com/imarpe>

The screenshot shows a web browser window displaying a GitHub repository page. The browser's address bar shows the URL `https://github.com/imarpe/dorado-dolphinfish`. The repository name is `imarpe / dorado-dolphinfish`. The page features a navigation bar with options for Pull requests, Issues, and Gist. Below the repository name, there are statistics: 14 commits, 1 branch, 0 releases, and 3 contributors. A table lists recent commits, including updates to `README.md`, `MSY-Catch`, `cpue`, `surplusProduction`, `.gitignore`, and `README.md`. The main content area displays the `README.md` file, which contains the title **Dorado (Perico - Mahi mahi - dolphin fish)** and the subtitle **Stock assessment models for Coryphaena hyppurus (Perico) in Peru**. On the right side, there are options to clone the repository via SSH, HTTPS, or Subversion, and buttons for 'Clone in Desktop' and 'Download ZIP'.

imarpe/dorado-dolphin x
← → ↻ 🏠 [GitHub, Inc. \[US\]](#) <https://github.com/imarpe/dorado-dolphinfish> 🔍 ⚙️ ☆

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Stock assessment models for Coryphaena hyppurus (Perico) in Peru — Edit

🕒 14 commits 🌿 1 branch 📦 0 releases 👤 3 contributors

🔄 Branch: master dorado-dolphinfish / +

| | |
|----------------------------|--|
| ejosymart Update README.md | Latest commit 52d1516 just now |
| 📁 MSY-Catch | MSY-Catch 2 hours ago |
| 📁 cpue | Update cpue_standardization_functions.R 2 months ago |
| 📁 surplusProduction | Update JAGSsurplusProduction.R 3 hours ago |
| 📄 .gitignore | Update .gitignore 2 hours ago |
| 📄 README.md | Update README.md just now |

📖 README.md

Dorado (Perico - Mahi mahi - dolphin fish)

Stock assessment models for Coryphaena hyppurus (Perico) in Peru

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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

