

Using (S)ARIMA models to assess data-poor fisheries



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Data Poor Fisheries

- Present low diversity and/or quantity and/or quality of data (frequently only landings data)
- Present reduced information on the species biology and exploitation patterns
- Experience significant budget and staff constraints in research and management
- Can hardly be monitored with complex multivariate deterministic models

(S)ARIMA Models

- Univariate, simple and flexible
- Large statistical background (1978 -)
- >100 primary literature applications

$$\text{SARIMA } (p, d, q) \times (P, D, Q)_S$$

$$\phi(B)\Phi(B^S)(1-B)^d(1-B^S)^D X_t = \theta(B)\Theta(B^S)Z_t$$

where

$$\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - \dots - \phi_p B^p \quad \Phi(B^S) = 1 - \Phi_1 B^S - \Phi_2 B^{2S} - \dots - \Phi_P B^{PS}$$

$$\theta(B) = 1 + \theta_1 B + \theta_2 B^2 + \dots + \theta_q B^q \quad \Theta(B^S) = 1 + \Theta_1 B^S + \Theta_2 B^{2S} + \dots + \Theta_Q B^{QS}$$

and

$$(1-B)^d(1-B^S)^D X_t \text{ is stationary}$$

Statistical Process Control (SPC) framework for fisheries monitoring

1. Model available univariate data (e.g., fisheries landings) with (S)ARIMA.
2. Obtain monthly/annual predictions and determine their prediction intervals
3. Use prediction intervals as alarm thresholds in detecting changes in the data generating process

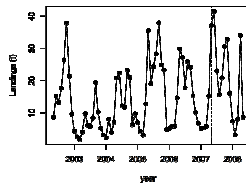
$$PI_{ms,h} = \hat{x}_h \pm t_{df, \frac{\alpha}{2}} \sqrt{PMSE_h}$$

where $PMSE_h$ is the prediction MSE at step h

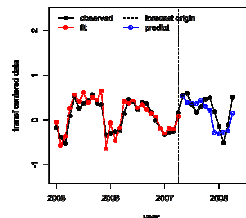
Case-study 1

Sp: Meagre
Area: Lisboa, Central Portugal
Fishery Type: Artisanal
Gear: Longlines and nets
Assessment/Monitoring: No
Data: 60+12 monthly landings
Model: SARIMA(0,0,5) x (1,1,0)₁₂

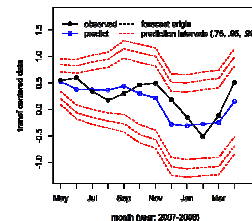
1. Data



2. Prediction



3. Monitoring

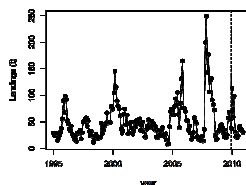


Conclusion:
 Landings are in-control

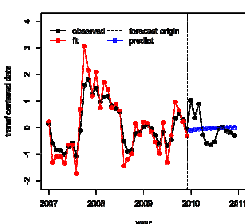
Case-study 2

Sp: Common octopus
Area: Santa Luzia, SE Portugal
Fishery Type: Artisanal
Gear: pots and traps
Assessment/Monitoring: No
Data: 180+12 monthly landings
Model: ARMA(1,1)

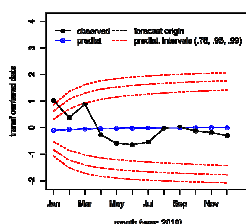
1. Data



2. Prediction



3. Monitoring

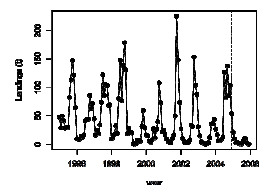


Conclusion: landings in-control!

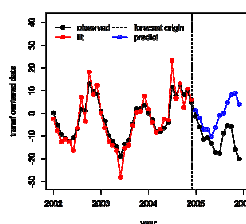
Case-study 3

Sp: Common squid
Area: NW Portugal
Fishery Type: Industrial
Gear: trawl
Assessment/Monitoring: No
Data: 108+12 monthly landings
Model: SARIMA(4,0,2) x (0,1,1)₁₂

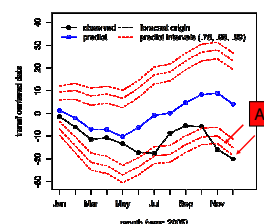
1. Data



2. Prediction



3. Monitoring



Conclusion: landings out-of-control!