Método de Zhou 2013

PCOM Posterior-focused catch-only method S. Zhou, Modificado por Elson Leal para sardina austral Aysen 2019, CBA 2020

This method requires time series of catch data only. However, some life history parameters, M, Linf, k, T_max, T_maturation, will improve the performance. Also, a rough guess of maximum depletion level D = B_end/K will be helpful. This example is for single catch series

Modelo

```
library(knitr) # para generar reporte Rmarkdown
library(stringr)
library(reshape)
library(dplyr)
library(ggplot2)
library(ggthemes) # para ggplot
library(patchwork) # para unir gráficos de ggplot
library(strucchange) # libreria utilizada para análisis de quiebres

getwd()
```

```
## [1] "/Users/mariajosezunigabasualto/MJZ/CTP2021/SARDINA_AUSTRAL AYSEN/INFORME_FINAL"
```

```
###############################################################################################
# model
###############################################################################################
BDM=function(K,dep,b,C,r){  ### biomass dynamics model
 B=err.B=rep(NA,length(C))
 B[1]=b*K;b1=B[1]
 for(i in 2:length(B)){
  B[i]=max(min(B[i-1]+r*B[i-1]*(1-B[i-1]/K)-C[i-1],K),0)
#  err.B[i]=ifelse(!is.na(U[i-1]&U[i]) & B[i]>0,(B[i-1]/B[i]-U[i-1]/U[i]^2,NA)
 }
 if(all(B>C) & all(B<=K)){
  abs(B[length(B)]-dep*K)
# if(any(U>0)){((B[length(B)]-dep*K)/K)^2 +sum(err.B,na.rm=T)} else ((B[length(B)]-dep*K)/K)^2
 } else {10^5}
}
```

Simulación

```r
##########################################################################################
# simulation
##########################################################################################
sim1=function(k25=k25,k75=k75,r25=r25,r75=r75,yr=yr,C=C,nsim=nsim,msy=NULL){
 Bend.keep=K.keep=r.keep=dep.keep=d.keep=vector()
 nyr=length(yr)
 B=F2Fmsy=B2Bmsy=matrix(NA,nyr,nsim)
 K=r=vector()
 plot(0,0,type="n",xlim=c(min(yr),max(yr)),ylim=c(-1,round(k75,0)*1.15),
 xlab="", ylab="",yaxt="n",xaxt="n")
 for(j in 1:nsim){
   K[1]=runif(1,k25,k75)
   r[1]=runif(1,r25,r75)
   B[1,j]=K[1]
   for(i in 2:(nyr)){
     r[i]=runif(1,r25,r75)
     K[i]=runif(1,k25,k75)
     B[i,j]=B[i-1,j]+r[i]*B[i-1,j]*(1-B[i-1,j]/K[i])-C[i-1]
     F2Fmsy[i,j]=(C[i]/B[i,j])/(r[i]/2)
     B2Bmsy[i,j]=B[i,j]/(K[i]/2)
   }
   cols<-rgb(runif(1,0,j)/nsim,(nsim-runif(1,0,j))/nsim,(1)/(nsim+100),
   alpha=0.6)
   lines(yr,B[,j],col=cols)
   K.keep[j]=mean(K)
   r.keep[j]=mean(r)
   F2Fmsy[,j]=(C/B[,j])/(mean(r)/2)
   B2Bmsy[,j]=B[,j]/(mean(K)/2)
 }
 Bend.keep=B[nyr,]
 d.keep=B[nyr,]/mean(K)
 lines(yr,apply(B,1,median),lty=1,lwd=3)
 lines(yr,C,lwd=2,col="#363636",lty=2)
 points(yr,C,pch=21,col=4,bg=4,cex=1.3)
 y1<-seq(0,round(k75,0)*1.1,le=5);
 x1<-seq(1,length(yr),by=1)
 axis(1,at=yr[x1],labels=yr[x1],las=1,cex.axis=1)
 axis(2,at=y1,labels=format(round(y1/1000,0),3),las=2,cex.axis=1)
 legend(yr[nyr-4],max(y1)*1.05,c("Biomasa","Captura","RMS"),lty=c(1,2,2),
 col=c(1,"#363636",2),pch=c(NA,21,NA),lwd=c(2,2,2),pt.bg=c(NA,4,NA),cex=1.3,bty="n")
 BC<-expression(paste('Biomasa ('%*%'1000 ton) y Captura (ton)',sep=""))
 mtext(BC,side=2,line=4.0,cex=1)
 mtext("Años",side=1,line=3.5,cex=1)
 if(is.null(msy)){} else {abline(h=msy,lty=2,col=2,lwd=2)}
 msy=K.keep*r.keep/4
 return(list(K.keep,r.keep,msy,Bend.keep,d.keep,B,r,F2Fmsy,B2Bmsy))
}
```

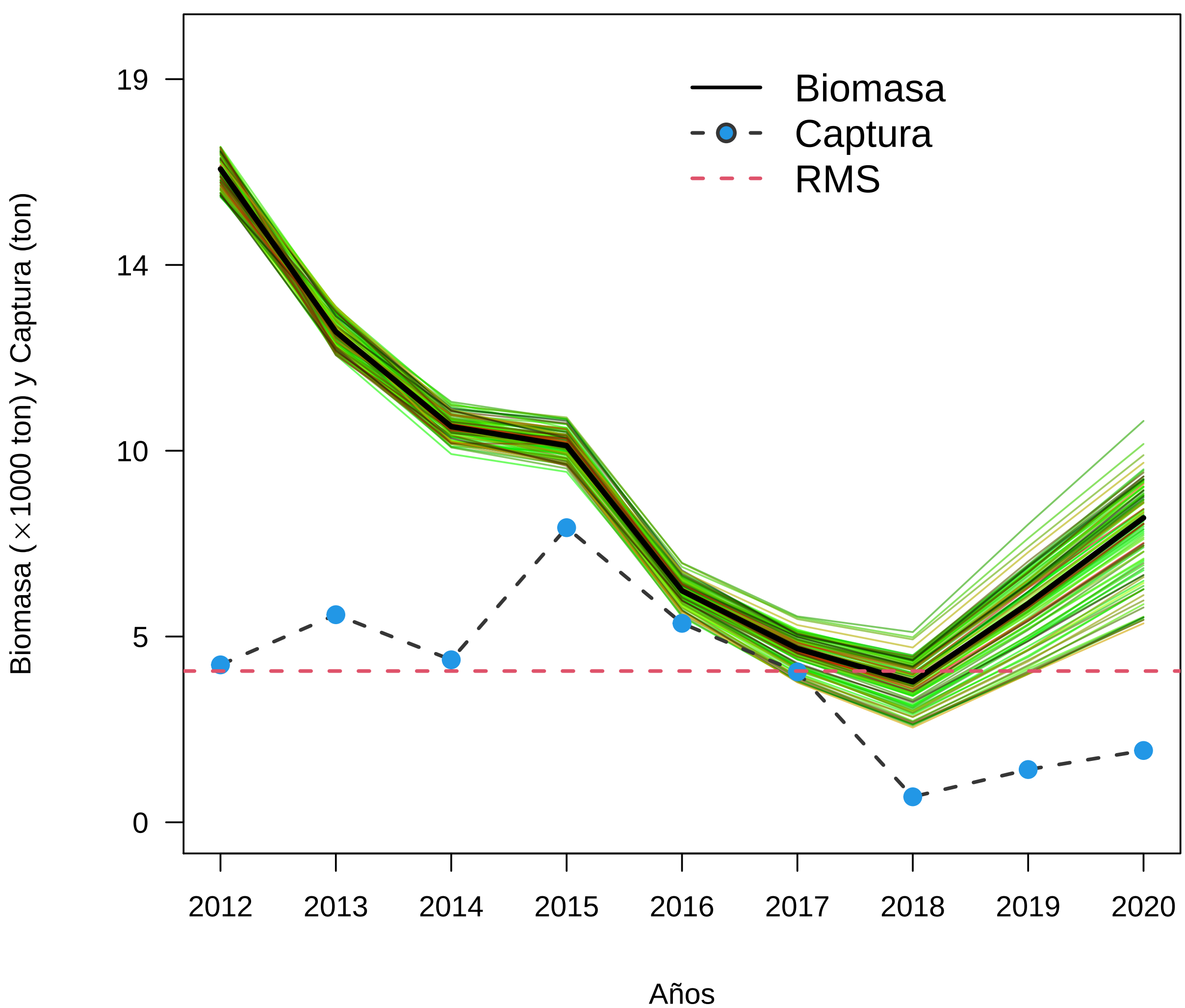
Ingresa datos de captura

```
#
########################################################################
# input catch data and r range for sautral XI stock
C=c(4033,5318,4163,7547,5097,3853,653,1352,1839)
yr=seq(2012,2020)
r.lci=0.85;
r.uci=1.2
# search through K grids, with specific range for K1 follow
N1=100
K1=exp(seq(log(max(C)),log(max(C)*50),l=N1))
# genera los valores de la deplecion
dep=round(seq(0.1,0.8,0.05),2)
nd=length(dep)
r1=obj1=matrix(0,N1,nd)  #matriz que almacena los output de las funciones
b=1#Si (C[1]/max(C)<0.5, (0.5+0.9)/2 (0.3+0.6)/2);b=0.5
# ciclo
for(j in 1:nd){
  for(i in 1:N1){
    out=optimize(BDM,K=K1[i],b=b,C=C,dep=dep[j],
    interval=c(r.lci-.05,r.uci+.05))
    r1[i,j]=out$min
    obj1[i,j]=out$obj
  }
}


#
#vLinf=58.95;vk=0.28;Tmax=10;Tmat=NA;T=17
#M=vector()
#M[1]=exp(1.44-0.982*log(Tmax))
#M[2]=1.65/Tmat
#M[3]=exp(1.2-0.17*log(vLinf)+log(vk))
#M[4]=1.82*vk
#M[5]=exp(-0.0152-0.279*log(vLinf)+0.6543*log(vk)+0.463*log(T))
#w=0.87 #para teleost y w=0.41 para chondrithys
#r.mean=2*mean(M,na.rm=T)*w
#r.sd=sd(M,na.rm=T)
#r.backup=r
#r[r > r.mean+2*r.sd | r < r.mean-2*r.sd]=NA

##############################
r1.backup=r1  ;# r1=r1.backup
r1[obj1 > K1*0.01]=NA
r1[r1 > r.uci | r1 < r.lci]=NA
##############################
kr=as.data.frame(cbind(K1,r1))
colnames(kr)=c('k',dep)
all=cbind(K1,stack(kr[,2:nd+1]))#antes nd+1
colnames(all)=c("k","r","ind")
all$d=as.numeric(as.character(all$ind))
all=all[,c(1,2,4)]
all=all[!is.na(all[,2]),]
```

```r
all$msy=all[,1]*all[,2]/4
# estimate reference points
#cutoff=ifelse(tail(C,1)/max(C)<=0.5,0.5,0.8)
all2     =all[!is.na(all$r) & all$d <= 0.50,]#cutoff,assume upper depeltion=0.4
quan1    =apply(all2,2,quantile)
k25      =quan1[,1][2];k75=quan1[,1][4]
r25      =quan1[,2][2];r75=quan1[,2][4]
msy.media=quan1[,4][3]
all3     =all2[all2$k>k25 & all2$k<k75 & all2$r>r25 & all2$r<r75,]
para     =list(k25=k25,k75=k75,r25=r25,r75=r75)
```

Figura biomasa

```
#####################################################################################
nsim=100
#GRAFICA LA BIOMASA
par(mar=c(5,5.5,1,1),cex.axis=1.3,cex.lab=1.3)
out1=sim1(k25=k25,k75=k75,r25=r25,r75=r75,C=C,yr=yr,nsim=nsim,msy=msy.media)
```




```
#####################################################################################
#EXTRAE DATOS DE INTERES PARA LA INCERTIDUMBRE
#####################################################################################
F2Fmsy  =as.data.frame(out1[8]);
B2Bmsy  =as.data.frame(out1[9])
quant   =function(x)quantile(x,c(0.2,0.8))

dat.out =data.frame(year=yr,
                    B2Bmsy.med=apply(B2Bmsy,1,median),
                    quan1.B=apply(B2Bmsy,1,quant)[1,],
                    quan3.B=apply(B2Bmsy,1,quant)[2,],
```

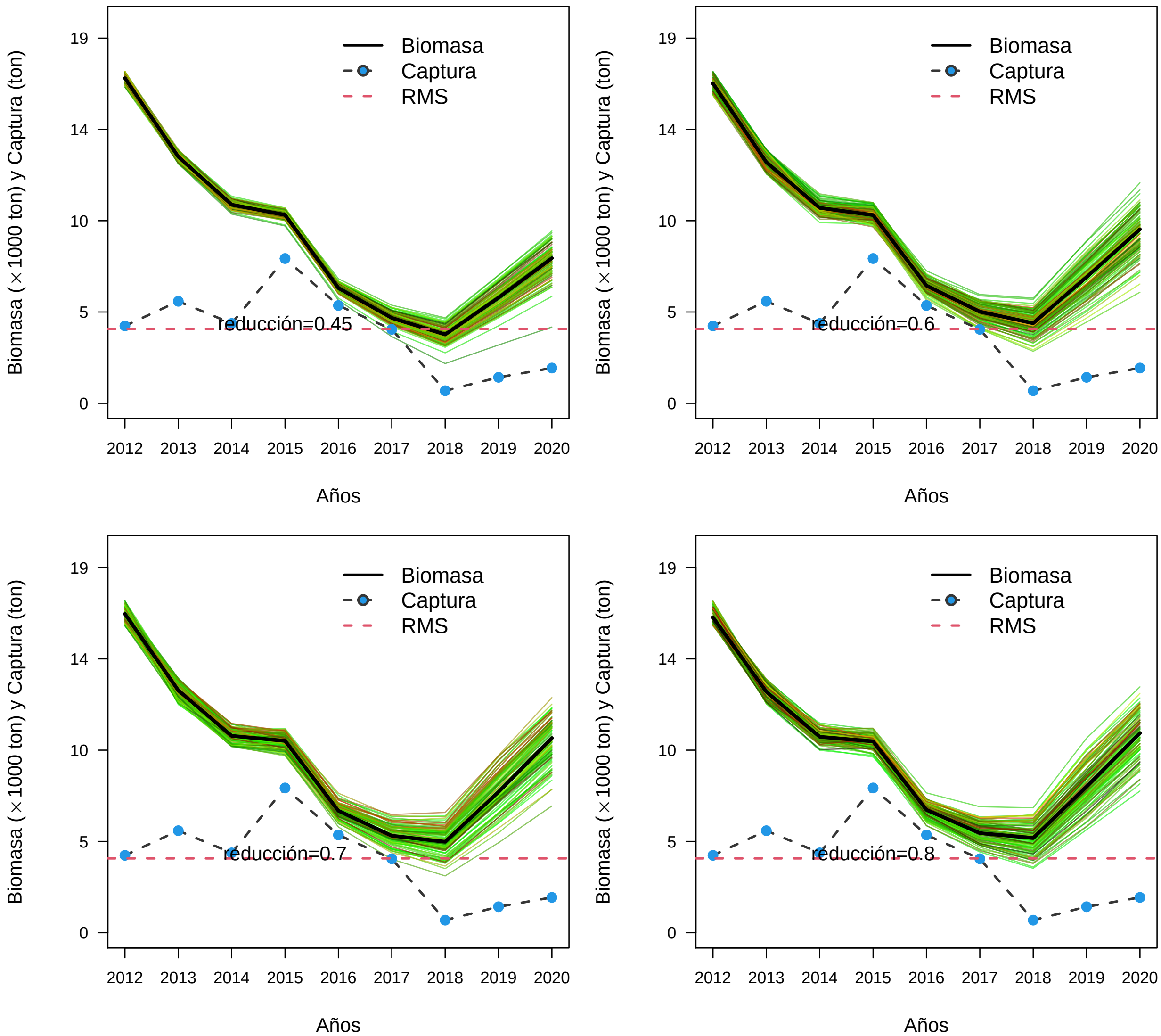
```r
                    F2Fmsy.med=apply(F2Fmsy,1,median),
                    quan1.F=apply(F2Fmsy,1,quant)[1,],
                    quan3.F=apply(F2Fmsy,1,quant)[2,])

BF2msy.end = data.frame(t(rbind(B2Bmsy[length(yr),],F2Fmsy[length(yr),])))
colnames(BF2msy.end)=c("B2Bmsy","F2Fmsy")
#kable(BF2msy.end)
#
out1.backup=out1 #out1=out1.backup
sp=out1[1:5]
sp=as.data.frame(sp)   # summary(sp)
colnames(sp)=c("k","r","msy","Bend","Depletion")
BendD=apply(sp,2,quantile)
###############################################################
#FINAL RESULT
tabla<-cbind(quan1[,c(1,2,4)],BendD[,4:5])
write.csv2(tabla,"tabla1.csv",row.names=FALSE)
kable(tabla)
```

	k	r	msy	Bend	Depletion
0%	15370.15	0.8508866	3681.066	5095.755	0.3074916
25%	15989.66	0.8904154	3794.954	6748.229	0.4072064
50%	16634.15	0.9265434	3874.717	7798.342	0.4705730
75%	17304.61	0.9811221	3944.479	8503.888	0.5131476
100%	17304.61	1.0621235	4081.248	10280.827	0.6203729

```r
Bioma <-apply(out1.backup[[6]],1,quantile)
#note: Bmsy = k/2, Blim = k/4
B.sim =data.frame(out1[6])
BF    =t(apply(B.sim,1,quantile))
BF    =cbind(BF,C/BF)
BRP   =c(quan1[3,1]/2,quan1[3,2]/2)
fs    =data.frame(cbind(BF[,c(8,3)],yr)) # F y Biomasa media
#GRAFICA BIOMASA V/S CPUE
#plot(yr,BF[,3],type="b",ylab="Biomasa and CPUE")
#par(new=T)
#plot(yr,U,type="b",col=2,axes=F,xlab="",ylab="")
#
```

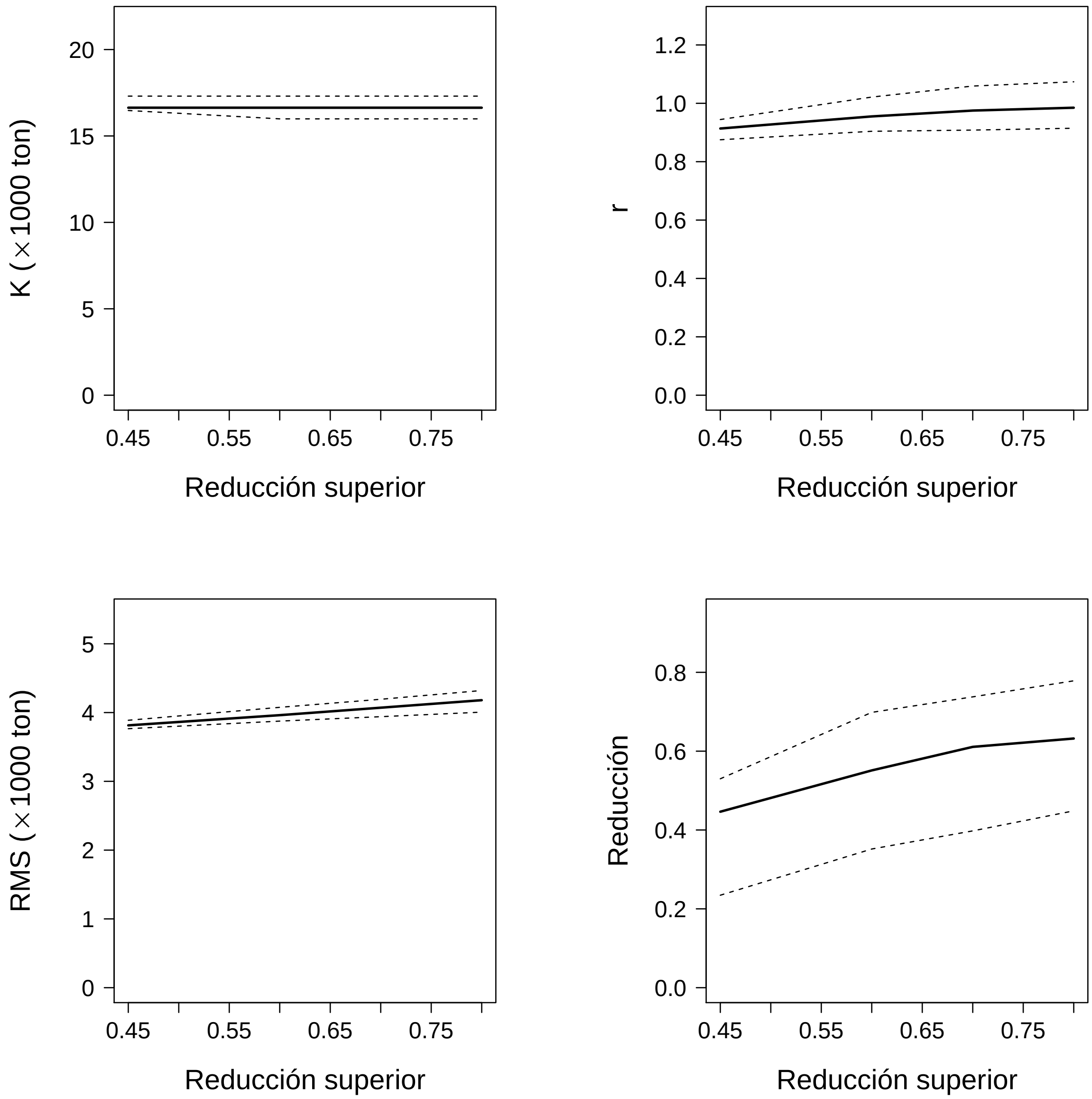
Sensibilidad

```r
#######################################################
#  sensitivity to assumed upper depletion (if needed) #
#######################################################
med.out=low.out=up.out=matrix(NA,nrow=4,ncol=6)
d.l=c(0.45,0.6,0.7,0.8)  # assumed upper depletion levels
layout(matrix(1:4,ncol=2,byrow=T),widths=c(1,1),heights=c(1,1))
for(i in 1:4){
  all2=all[!is.na(all$r) & all$d <= d.l[i],]
  quan1=apply(all2,2,quantile)
  k25=quan1[,1][2]
  k75=quan1[,1][4]
  r25=quan1[,2][2]
  r75=quan1[,2][4]
  msy.median=quan1[,4][3]
  nsim=100
  ##################################################################################
  #Figura
  par(mar=c(5,5.5,1,1),cex.axis=1.3)
  out1=sim1(k25=k25,k75=k75,r25=r25,r75=r75,C=C,yr=yr,nsim=nsim,msy=msy.media)
  tex=paste("reducción=",d.l[i],sep="")
  text(2015,round(para$k25,0)*0.26,tex,cex=1.2,xpd=T)
  ##################################################################################
  # Tablas
  sp  = out1[1:5]
  sp  = as.data.frame(sp)   # summary(sp)
  colnames(sp)= c('k','r','msy','Bend','D')
  BendD = apply(sp,2,quantile)

  med.out[i,] =(c(quan1[3,],BendD[3,4:5]))
  low.out[i,] =(c(quan1[2,],BendD[1,4:5]))
  up.out[i,]  =(c(quan1[4,],BendD[5,4:5]))

  med.out[,3] =t(d.l)
  low.out[,3] =t(d.l)
  up.out[,3]  =t(d.l)

  colnames(med.out)=c("k","r","d.upper","msy","Bend","D")
  colnames(low.out)=c("k","r","d.upper","msy","Bend","D")
  colnames(up.out)=c("k","r","d.upper","msy","Bend","D")

  kable(med.out)
  kable(low.out)
  kable(up.out)
  ##################################################################################
}
```



Biomasa
Captura
RMS
reducción=0.45
reducción=0.6
reducción=0.7
reducción=0.8
Biomasa (×1000 ton) y Captura (ton)
Años
19
14
10
5
0
2012
2013
2014
2015
2016
2017
2018
2019
2020

```r
###############################################################################################
# parameters as a function of assumed upper depletion level
###############################################################################################
#name3<-paste(getwd(),"/Figuras/Fig3_Zhou2013_sensitivity.png",sep="")
#png(file=name3,width=900,height=1000)
layout(matrix(1:4,ncol=2,byrow=T),widths=c(1,1),heights=c(1,1))
par(mar=c(5.6,6.7,4,4),cex.axis=1.4)

plot(med.out[,3],med.out[,1]/1000,ylim=c(0,max(med.out[,1]/1000*1.3)),type='l',lwd=2,xlab='',ylab='',las
lines(low.out[,3],low.out[,1]/1000,lty=2);lines(up.out[,3],up.out[,1]/1000,lty=2)
mtext(expression(paste('K ('%*%'1000 ton)')),side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)

plot(med.out[,3],med.out[,2],ylim=c(0,max(med.out[,2]*1.3)),type='l',lwd=2,xlab='',ylab='',las=1)
mtext('r',side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)
lines(low.out[,3],low.out[,2],lty=2);lines(up.out[,3],up.out[,2],lty=2)

plot(med.out[,3],med.out[,4]/1000,ylim=c(0,max(med.out[,4]/1000*1.3)),type='l',lwd=2,xlab='',ylab='',las
lines(low.out[,3],low.out[,4]/1000,lty=2);lines(up.out[,3],up.out[,4]/1000,lty=2)
mtext(expression(paste('RMS ('%*%'1000 ton)')),side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)

plot(med.out[,3],med.out[,6],ylim=c(0,max(med.out[,6]*1.5)),type='l',lwd=2,xlab='',ylab='',las=1)
lines(low.out[,3],low.out[,6],lty=2);lines(up.out[,3],up.out[,6],lty=2)
mtext("Reducción",side=2,line=3.8,cex=1.4)
mtext("Reducción superior",side=1,line=3.6,cex=1.4)
```




```
#dev.off()
```

```
###############################################################################################
# GRAFICA DIAGRAMA DE FASE
###############################################################################################
library(MASS)

K       <- med.out[1,1]
mc.dat <-BF2msy.end
Bmrs    <-tabla[3,1]/2 #BMRS
Fmrs    <-tabla[3,2]/2 #FMRS
Fest    <-C/Bioma[3,] #F anual
Y1      <-Fest/Fmrs;
X1      <-Bioma[3,]/Bmrs
```

```r
Z1     <-Bioma[3,]/K
#h=rep(0.13,4)
z<-kde2d(mc.dat[,1],mc.dat[,2],n=100,
lims=c(range(c(0,max(X1))),range(c(0,max(Y1)*1.7))))
est<-z$z/max(z$z);z$z<-est
#Bmrs=43590;Fmrs=0.3515;Fest=C/Bioma[3,]
#Y1<-Fest/Fmrs;X1<-Bioma[2,]/Bmrs
#
soli<-cbind(yr,round(Bioma[3,],0),round(Fest,2),round(Z1,2),round(X1,2),round(Y1,2))
colnames(soli)<-c("year","BD","Fest","B_Bo","Brel","Frel")

kable(soli)
```

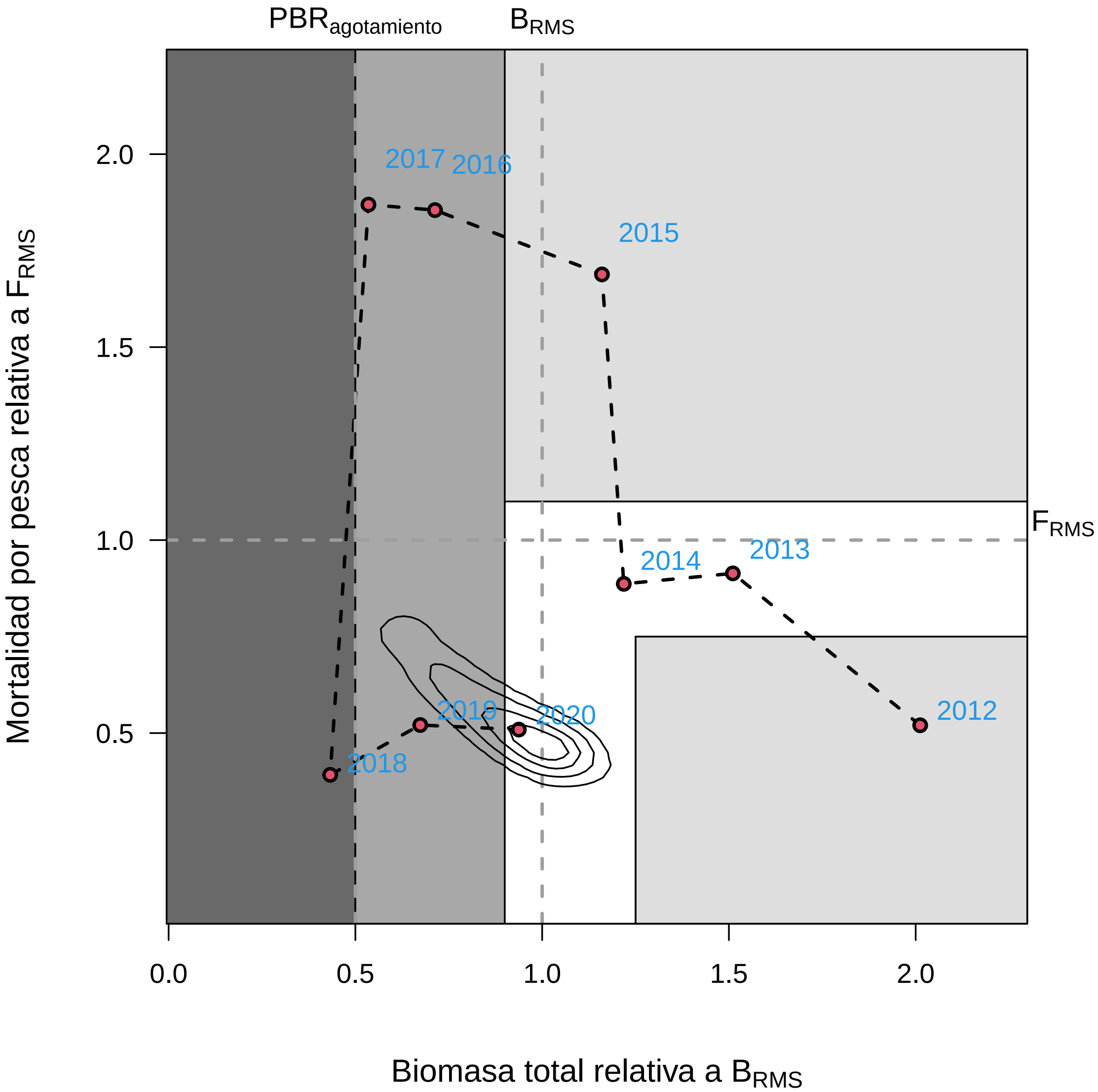
year	BD	Fest	B_Bo	Brel	Frel
2012	16735	0.24	1.01	2.01	0.52
2013	12563	0.42	0.76	1.51	0.91
2014	10136	0.41	0.61	1.22	0.89
2015	9649	0.78	0.58	1.16	1.69
2016	5931	0.86	0.36	0.71	1.86
2017	4449	0.87	0.27	0.53	1.87
2018	3598	0.18	0.22	0.43	0.39
2019	5603	0.24	0.34	0.67	0.52
2020	7798	0.24	0.47	0.94	0.51

```r
kable(rbind(Bmrs,Fmrs))
```

Bmrs	8317.0750007
Fmrs	0.4632717

```r
#library(rJava)                                             ## PROBLEMAS CON ESTO
#library(xlsx)
write.csv2(soli,"tabla2.csv",row.names=FALSE)
#DEFINE LAS AREAS DE LOS POLIGONOS
cols<-c("#696969","#A8A8A8","#DEDEDE")
ini<-c(-0.09);
xmax<-max(X1)*1.35;
ymax<-max(Y1)*1.22;
xmin<-(0.08)
pol1<-matrix(c(0.9,ini,0.9,1.1,xmax,1.1,xmax,0.75,1.25,0.75,1.25,ini),
ncol=2,byrow=T)
pol2<-matrix(c(1.25,ini,1.25,0.75,xmax,0.75,xmax,ini),ncol=2,byrow=T)
pol3<-matrix(c(xmax,1.1,xmax,ymax,0.9,ymax,0.9,1.1),ncol=2,byrow=T)
pol4<-matrix(c(0.5,ini,0.9,ini,0.9,ymax,0.5,ymax),ncol=2,byrow=T)
pol5<-matrix(c(-0.07,ini,0.5,ini,0.5,ymax,-0.07,ymax),ncol=2,byrow=T)

#name4<-paste(getwd(),"/Figuras/Fig4_Zhou2013_fase.png",sep="")
#png(file=name4,width=1200,height=1000)
par(mar=c(6.1,6.5,4.8,4.8),cex.axis=1,cex.lab=1)
plot(X1,Y1,col=0,xlab="",ylab="",yaxt="n",xlim=c(xmin,max(X1)*1.1),
ylim=c(0.09,max(Y1)*1.17))
axis(2,las=1)
```

```r
polygon(pol5,col=cols[1],border=1);polygon(pol4,col=cols[2],border=1)
polygon(pol3,col=cols[3],border=1);polygon(pol2,col=cols[3],border=1)
polygon(pol1,col="white",border="black")
#points(mc.dat[,1],mc.dat[,2],pch=21,bg="#B5B5B5",cex=0.9,col=1)
lines(X1,Y1,lty=2,col=1,lwd=2)
lines(X1,Y1,type="p",bg=2,pch=21,cex=1,lwd=2)
abline(v=1,lty=2,col=8,lwd=2);abline(h=1,lty=2,col=8,lwd=2)
abline(v=0.5,lty=2,col=8,lwd=2)
contour(z,drawlabels=FALSE,levels=c(0.1,0.25,0.5,0.75),add=TRUE)
text(0.5,max(Y1)*1.29,expression(PBR[paste("agotamiento")]),cex=1.1,
pos=1,xpd=T)
text(1,max(Y1)*1.29,expression(B[paste("RMS")]),cex=1.1,pos=1,xpd=T)
text(max(X1)*1.19,1.11,expression(F[paste("RMS")]),cex=1.1,pos=1,xpd=T)
mtext(expression(paste("Biomasa total relativa a ",B[paste("RMS")],sep="")),
side=1,line=4.2,cex=1.2)
mtext(expression(paste("Mortalidad por pesca relativa a ",F[paste("RMS")],
sep="")),side=2,line=3.8,cex=1.2)
#a2<-which(yr%in%seq(2015,1994,by=-2)==TRUE)
a2<-c(1,2,3,4,5,6,7,8,9)
text(X1[a2],Y1[a2]*1.06,yr[a2],cex=1,pos=4,col=4)
#text(1.10,0.83,"Plena Explotación",cex=1.6,pos=4,col=1,lwd=2)
#text(1.56,0.31,"Sub Explotación",cex=1.6,pos=4,col=1,lwd=2)
#text(1.33,1.51,"Sobrepesca",cex=1.6,pos=4,col=1,lwd=2)
#text(0.58,0.67,"Sobre",cex=1.6,pos=4,col=1,lwd=2)
#text(0.52,0.51,"Explotación",cex=1.6,pos=4,col=1,lwd=2)
#text(0.68,1.18,"Sobre-explotación y Sobrepesca",cex=1.6,pos=4,lwd=2,srt=90)
#text(0.23,1.18,"Colapso y/o Agotamiento",cex=1.6,pos=4,lwd=2,srt=90)
box()
```



PBR
agotamiento
B
RMS
F
RMS
2017
2016
2015
2014
2013
2012
2019
2020
2018
2.0
1.5
1.0
0.5
0.0
0.5
1.0
1.5
2.0
Mortalidad por pesca relativa a F
RMS
Biomasa total relativa a B
RMS

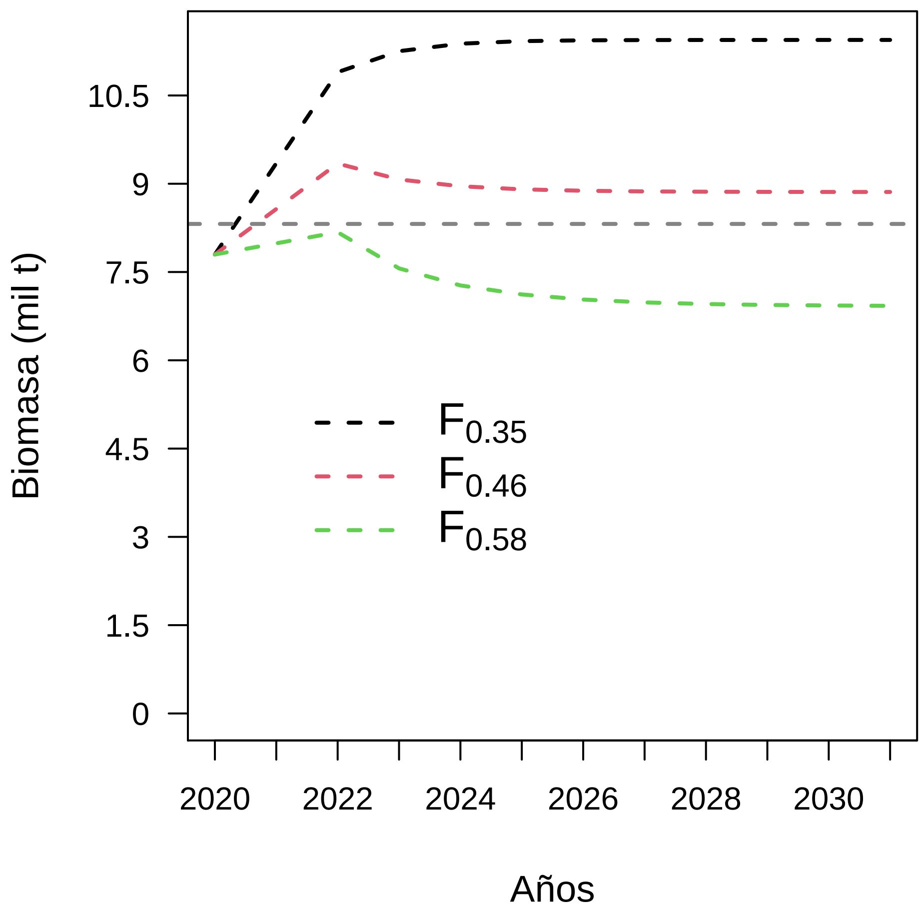

```
#dev.off()
```

Cálculo de CBA

```
#################################################################################################
#CALCULO DE LA CBA  PARA SARDINA AUSTRAL XI
#################################################################################################
mata <-out1.backup[1:5];
mm   <-length(mata)
mato <-vector()

for(p in 1:mm){
  mato <-cbind(mato,mata[[p]])}
  mate <-as.data.frame(mato)
  colnames(mate)<-c("k","r","msy","Bend","Depletion")

yy      <-length(yr)
prob    <-c(0.6666667,1.00,1.25) # pnderadores de Frms
ss      <-dim(sp)
yrs_pro <-seq(yr[yy],yr[yy]+11,by=1) # años de proyección
yyp     <-length(yrs_pro)

BT=CT=array(NA,c(length(prob),ss[1],length(yrs_pro)))

BT[,,1] <-Bioma[3,yy]
CT[,,1] <-C[yy]
Fi      <-Fmrs*prob

# y = Frms ponderados
# n = número de simulaciones
# m = años de proyección

for(y in 1:length(Fi)){
 for(n in 1:ss[1]){
  ki=sp$k[n] # parámetro K simulado
  ri=sp$r[n] # parámetro r simulado
  for(m in 1:(yyp-1)){ # PROYECCIÓN
   if(m==1){
     CT[y,,1]=C[yy]} # igual a la captura del último año
    else {
      CT[y,n,m]=BT[y,n,m]*Fi[y]} # captura proyectada
      BT[y,n,m+1]=BT[y,n,m]+ri*BT[y,n,m]*(1-BT[y,n,m]/ki)-CT[y,n,m] # biomasa total proyectada
   if(m==(yyp-1)){
     CT[y,n,m+1]=BT[y,n,m+1]*Fi[y]}
  }
 }
}
```

```
#################################################################################################
# GRAFICA LA CBA 2 PARA sardina austral
#################################################################################################
FF   <-formatC(Fi,format="f",digits=2)
BB   <-expression(paste("Biomasa (mil t)",sep=""))
Binf <-tabla[2,1]/2
Bsup <-tabla[4,1]/2
rng1 <-range(BT[,,],na.rm=T)
```

```
ax2  <-seq(0,rng1[2]*1.15,by=1500)
cols <-"#858585"
y1   <-length(yrs_pro)
xxxx<-matrix(ncol=3,nrow=11)

par(mar=c(5,5,1,1),cex.axis=1,cex.lab=1)
plot(yrs_pro[-2],seq(0,rng1[2]*1.15,le=(y1-1)),col=0,type="o",xlab="",ylab="",yaxt="n",ylim=c(0,rng1[2]

for(x in 1:length(Fi)){
  xxxx[,x]<-apply(BT[x,,],2,quantile)[3,-2]
 lines(yrs_pro[-2],xxxx[,x],col=x,lty=2,lwd=2)
}
abline(h=Bmrs,lty=2,lwd=2,col=cols)
axis(2,at=ax2,labels=ax2/1000,las=1,cex=1)
mtext(BB,side=2,line=3.5,cex=1.2)
mtext("Años",side=1,line=3.4,cex=1.2)
legend(2021,rng1[2]*0.5,c(expression(F[paste("0.35")]),expression(F[paste("0.46")]),
expression(F[paste("0.58")])),lty=c(2,2,2,2,2),lwd=c(2,2,2,2,2),cex=1.4,
col=c(1,2,3),bty="n")
```

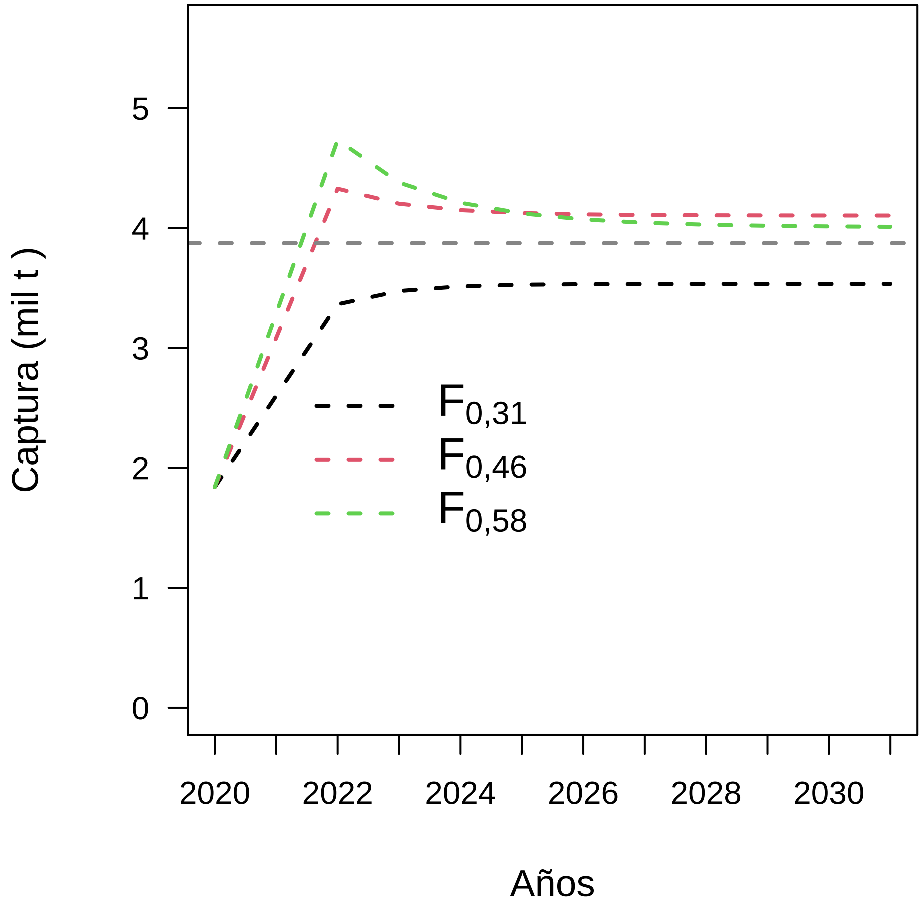



```
xxxx
```

```
##           [,1]     [,2]     [,3]
##  [1,]  7798.342 7798.342 7798.342
```

```
##   [2,] 10895.910 9342.693 8176.332
##   [3,] 11252.563 9072.942 7562.420
##   [4,] 11379.532 8957.372 7272.310
##   [5,] 11422.994 8905.102 7118.812
##   [6,] 11436.930 8881.089 7032.609
##   [7,] 11441.379 8869.757 6983.324
##   [8,] 11442.794 8864.432 6956.253
##   [9,] 11443.244 8861.926 6940.596
##  [10,] 11443.386 8860.744 6931.500
##  [11,] 11443.432 8860.187 6926.201
```

```
###################################################################################################
# GRAFICA LA CAPTURA
###################################################################################################
CC   <-expression(paste("Captura (mil t )",sep=""))
MRS  <-tabla[3,3] #50%
rng2 <-range(CT[,,],na.rm=T)
ax3  <-seq(0,rng2[2]*1.15,by=1000)

xxxx<-matrix(ncol=3,nrow=11)

par(mar=c(5,5,1,1),cex.axis=1,cex.lab=1)
plot(yrs_pro[-2],seq(0,rng2[2]*1.15,le=11),col=0,type="o",xlab="",ylab="",yaxt="n",ylim=c(0,rng2[2]*0.95

for(x in 1:length(Fi)){
  xxxx[,x]<-apply(CT[x,,],2,quantile)[3,-2]
 lines(yrs_pro[-2],xxxx[,x],col=x,lty=2,lwd=2)
}
abline(h=MRS,lty=2,lwd=2,col=cols)
axis(2,at=ax3,labels=sprintf("%0.0f",ax3/1000),las=1,cex=1.4)
mtext(CC,side=2,line=3.5,cex=1.2)
mtext("Años",side=1,line=3.4,cex=1.2)
legend(2021,rng2[2]*0.5,c(expression(F[paste("0,31")]),expression(F[paste("0,46")]),
expression(F[paste("0,58")])),lty=c(2,2,2,2,2),lwd=c(2,2,2,2,2),cex=1.4,
col=c(1,2,3),bty="n")
```




```
xxxx
```

```
##           [,1]     [,2]     [,3]
##  [1,] 1839.000 1839.000 1839.000
##  [2,] 3365.178 4328.206 4734.829
##  [3,] 3475.330 4203.237 4379.319
##  [4,] 3514.544 4149.697 4211.319
##  [5,] 3527.967 4125.482 4122.430
##  [6,] 3532.271 4114.357 4072.511
##  [7,] 3533.645 4109.107 4043.971
##  [8,] 3534.082 4106.641 4028.294
##  [9,] 3534.221 4105.479 4019.227
## [10,] 3534.265 4104.932 4013.960
## [11,] 3534.279 4104.674 4010.891
```

```
###########################################################################################
# TABLA DE RESULTADOS
###########################################################################################
ct<-matrix(NA,length(Fi),5)
for(i in 1:length(Fi)){
 ct[i,]<-as.numeric(quantile(CT[i,,2],probs=c(.1,.2,.3,.4,.5)))  # CT[i,,2] (el 2 representa 1 año de p
}
colnames(ct)<-c("10%","20%","30%","40%","50%")
rownames(ct)<-formatC(Fi,format="f",digits=2)
```

```r
cat("\n")
```

```r
print(ct)
```

```
##           10%      20%      30%     40%      50%
## 0.31 3080.818 3087.998 3097.759 3103.60 3108.949
## 0.46 4621.227 4631.997 4646.638 4655.40 4663.423
## 0.58 5776.534 5789.997 5808.297 5819.25 5829.279
```

```r
##################################################################################################
# RANGO CBA PARA PBR Al MRS (2) y EL 2021(2)
##################################################################################################
rango<-quantile(CT[2,,2],prob=c(0.025,0.25,0.50,0.75,0.975))

kable(rango)
```

	x
2.5%	4603.579
25%	4634.157
50%	4663.423
75%	4687.009
97.5%	4726.366

```r
#
#FIN
```