

A VAST model for the eastern GOA pollock assessment

Pollock in the eastern GOA historically have been assessed at Tier 5. The assessment consists of producing area-swept biomass estimates for the area encompassed by eastern GOA (east Yakutat and Southeast Alaska management areas), and then fitting a random effects (RE) model to the biomass estimates. Using the VAST model to assess the stock has the advantage of combining the two steps of historical assessments into single analysis that takes into account both spatial and temporal correlation of the stock. The VAST application utilized the temporal autocorrelation options available in VAST to perform the smoothing that was previously provided by the RE model. Several options for modeling autocorrelation are available: a random walk (RW), and an AR1 process. The code to run these models using the wrapper functions in VAST is the following:

```
#load data set
library(VAST)
workdat = read.csv('pollCPUE.csv')
#Catch data are CPUE rather than raw catches
workdat$Effort=1
#Data for eastern gulf only
workdat = subset(workdat, Long > -140)
#workdat = subset(workdat, Long > -159)
#Exclude the 1984 and 1987 surveys
workdat = subset(workdat, Year > 1989)

### Defining strata limits
strata.limits <- data.frame(
  'STRATA' = "east_of_140W",
  'west_border' = -140,
  'east_border' = Inf)
#settings = make_settings(..., strata.limits=strata.limits)
#For random walk process
RhoConfig = c("Beta1"=2,"Beta2"=2, "Epsilon1"=0,"Epsilon2"=2)
ObsModel=c(2,1)
#For AR1 process
#ObsModel=c(2,0)
#RhoConfig = c("Beta1"=4,"Beta2"=4, "Epsilon1"=0,"Epsilon2"=4)

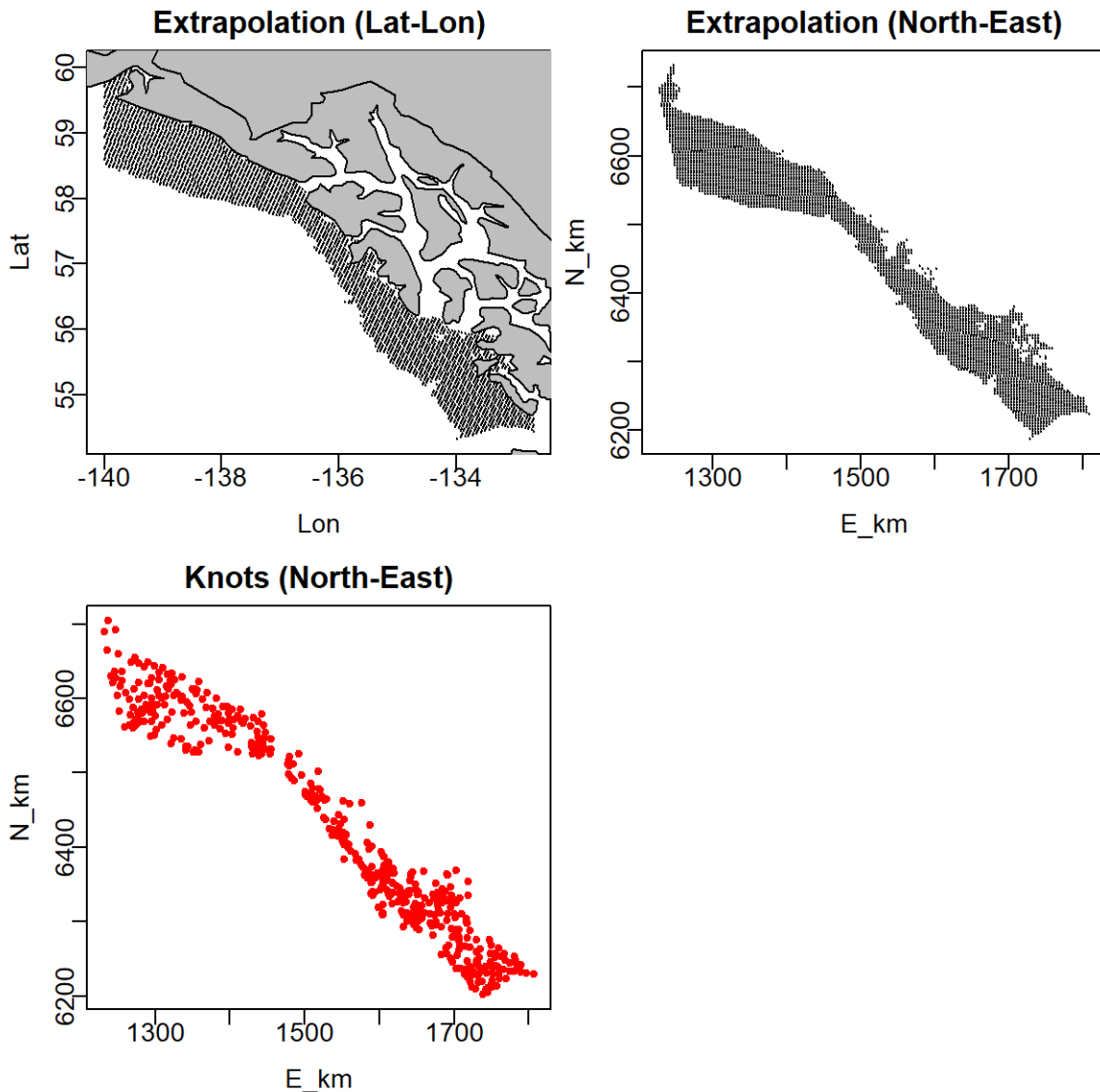
#Make settings
settings = make_settings( n_x=500, Region="gulf_of_alaska",
  ObsModel=ObsModel,purpose="index",
  RhoConfig=RhoConfig,strata.limits=strata.limits,bias.correct=TRUE,
  fine_scale=TRUE, treat_nonencounter_as_zero = FALSE)

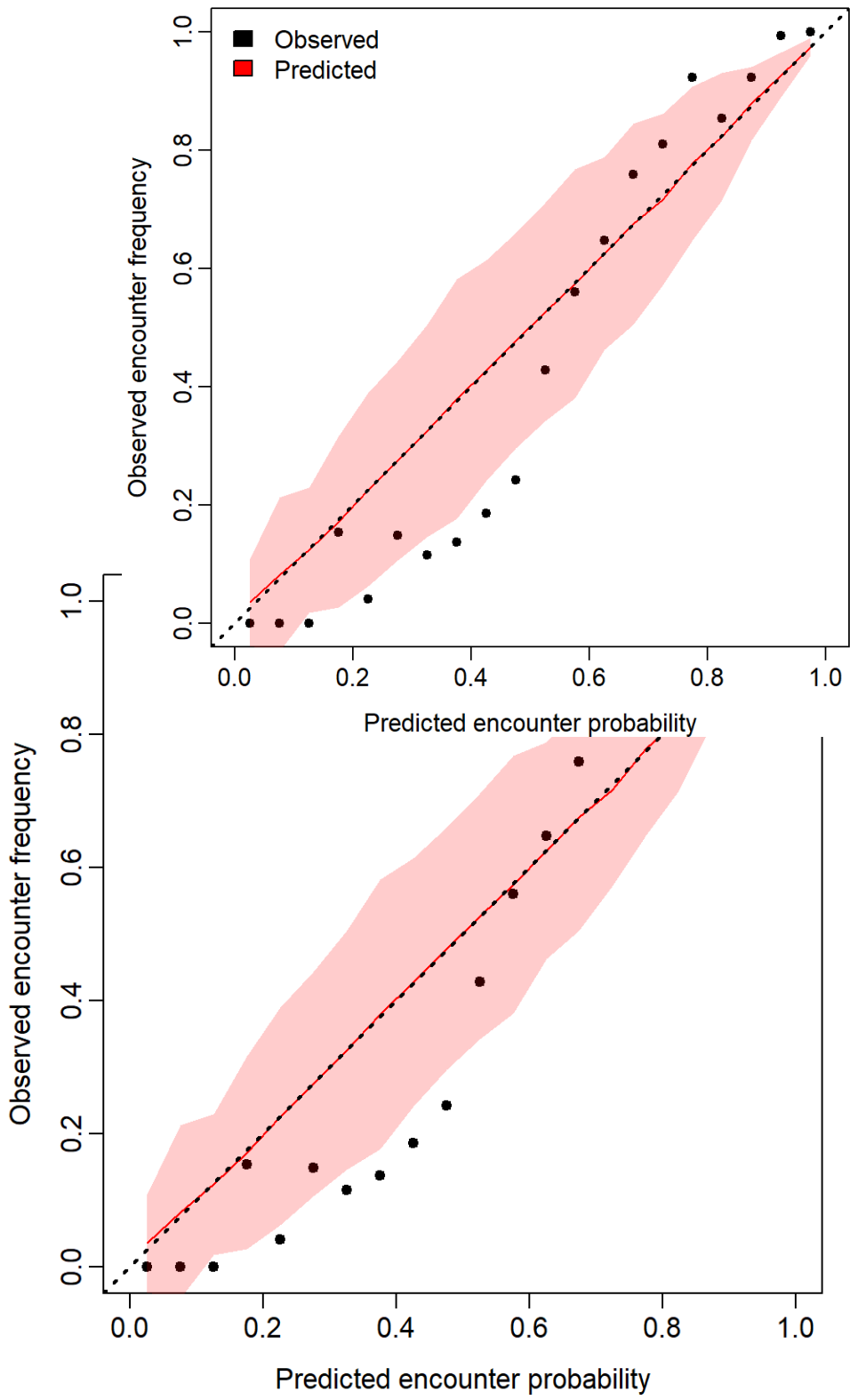
#Run model
dir.create('goawp8')
wd <- paste0(getwd(), '/goawp8/')
fit = fit_model( "settings"=settings, "Lat_i"=workdat[, 'Lat'],
  "Lon_i"=workdat[, 'Long'],
  "t_i"=as.numeric(workdat[, 'Year']),
  "c_i"=rep(0,nrow(workdat)), "b_i"=workdat[, 'WeightCPUE'],
  "a_i"=workdat[, 'Effort'],working_dir=wd)
```

```
#Plot results
plot( fit,working_dir=wd )
```

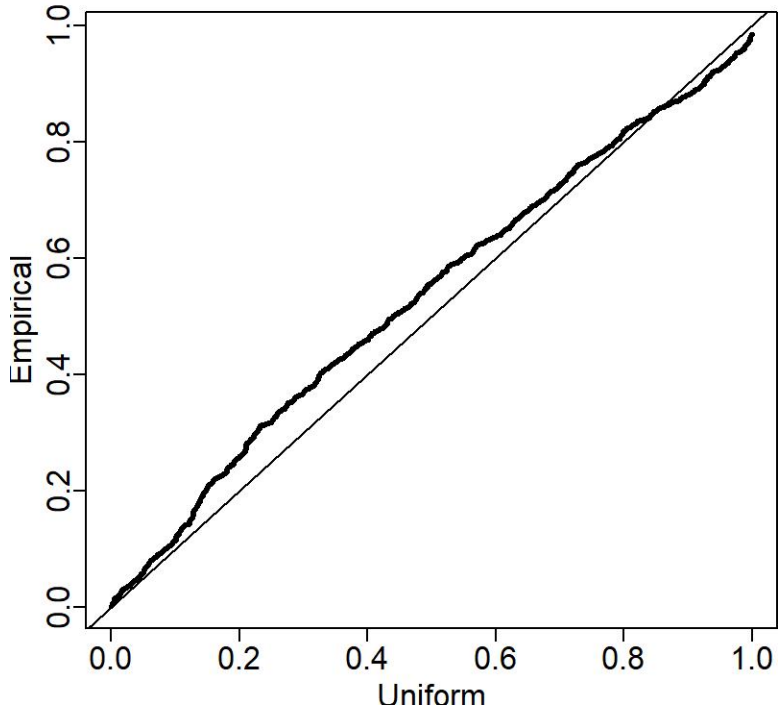
In general, estimation of the full suite of autocorrelation parameters (intercepts for the encounter probability and the positive catch rates, plus spatial-temporal variation for each) was not possible, and only a subset of the temporal parameters were estimated. Estimation problems arose only for modeling spatial-temporal variation in the encounter probability. For an AR1 process, the autoregressive coefficient "epsilon_rho1_f" had a large gradient and went to the parameter bound. For a random walk process, the variance term for temporal autocorrelation "L_beta1_z" went to zero. Both of these outcomes suggest that the data do not support modeling assumptions about autocorrelation in spatial-temporal processes for the encounter probability. Therefore epsilon1 was set zero in RhoConfig to turn off this process.

Model diagnostics appeared satisfactory—results for the RW VAST model are shown below:

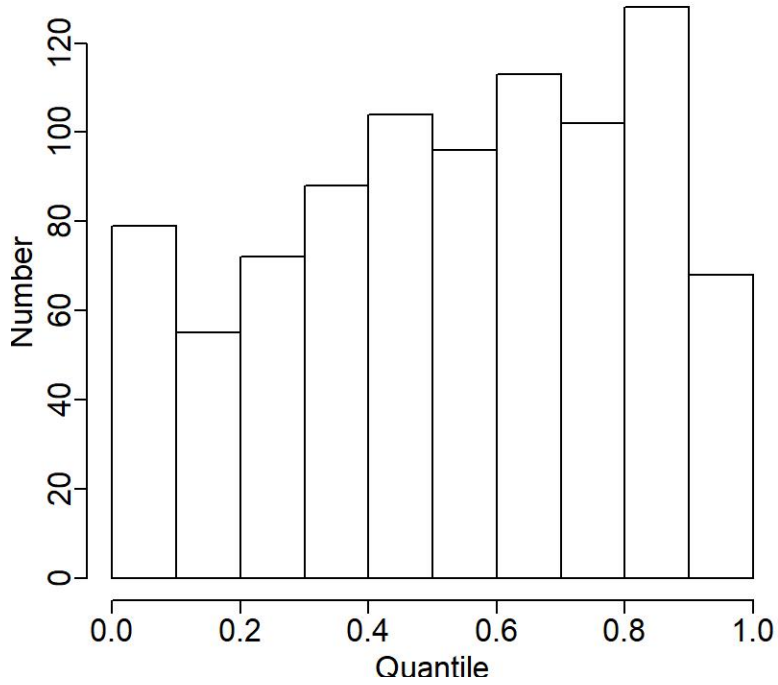




Q-Q plot



Quantile_histogram



Overall the results seemed reasonable. VAST produces less of a smoothing effect than the RE model, presumably because model-based annual estimates are more precise than design-based estimates, leading VAST to estimate higher process error (inter-annual variability).

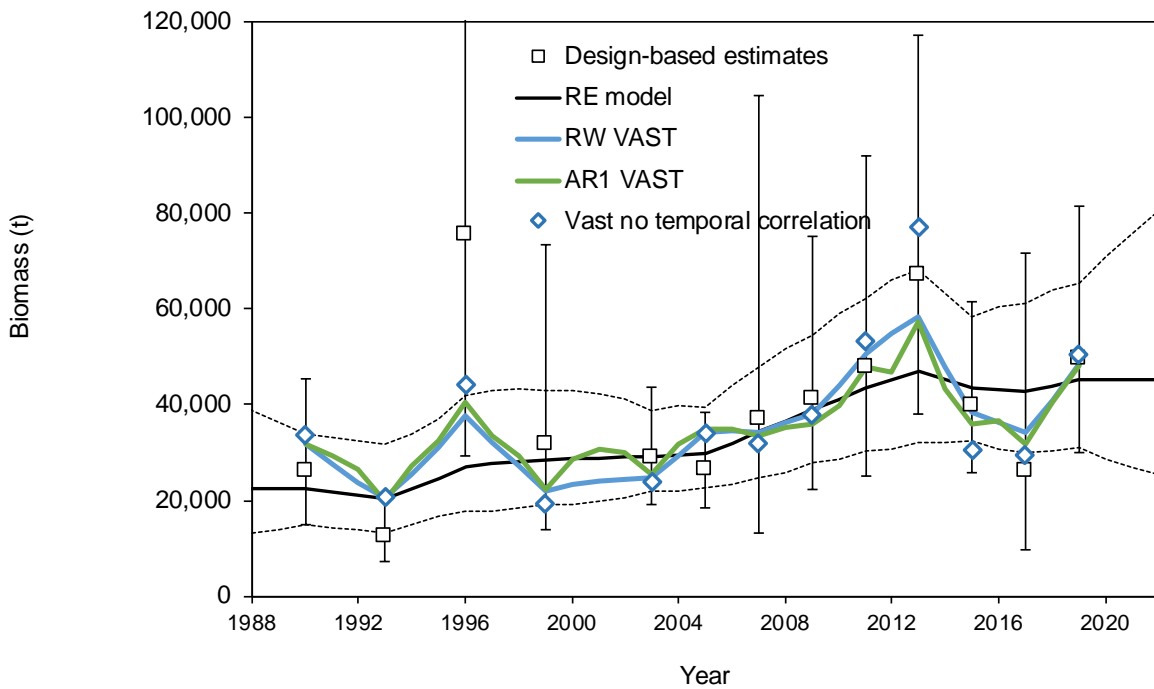


Figure 1. Biomass estimates for Southeast Alaska using various methods.