# Forecast

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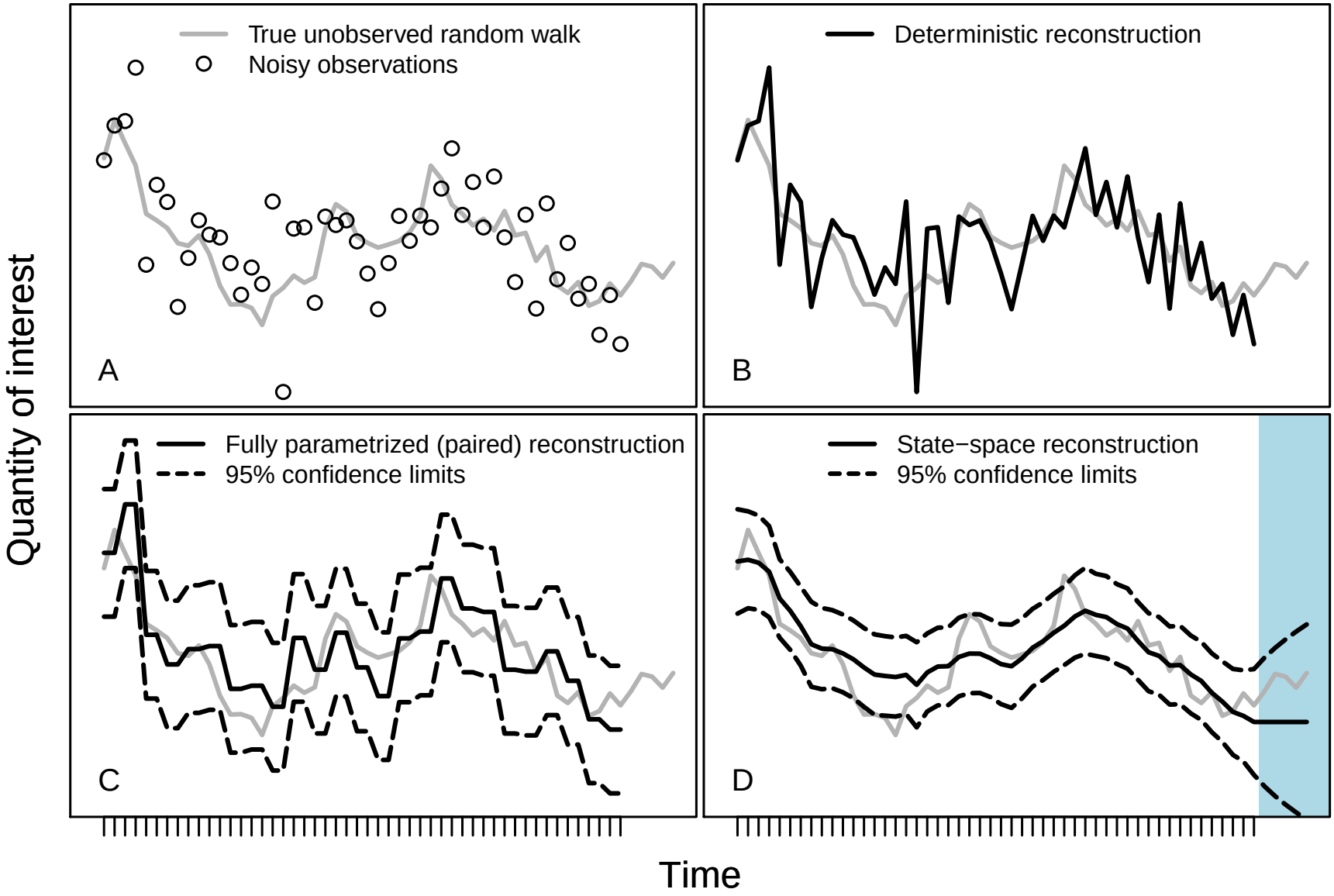
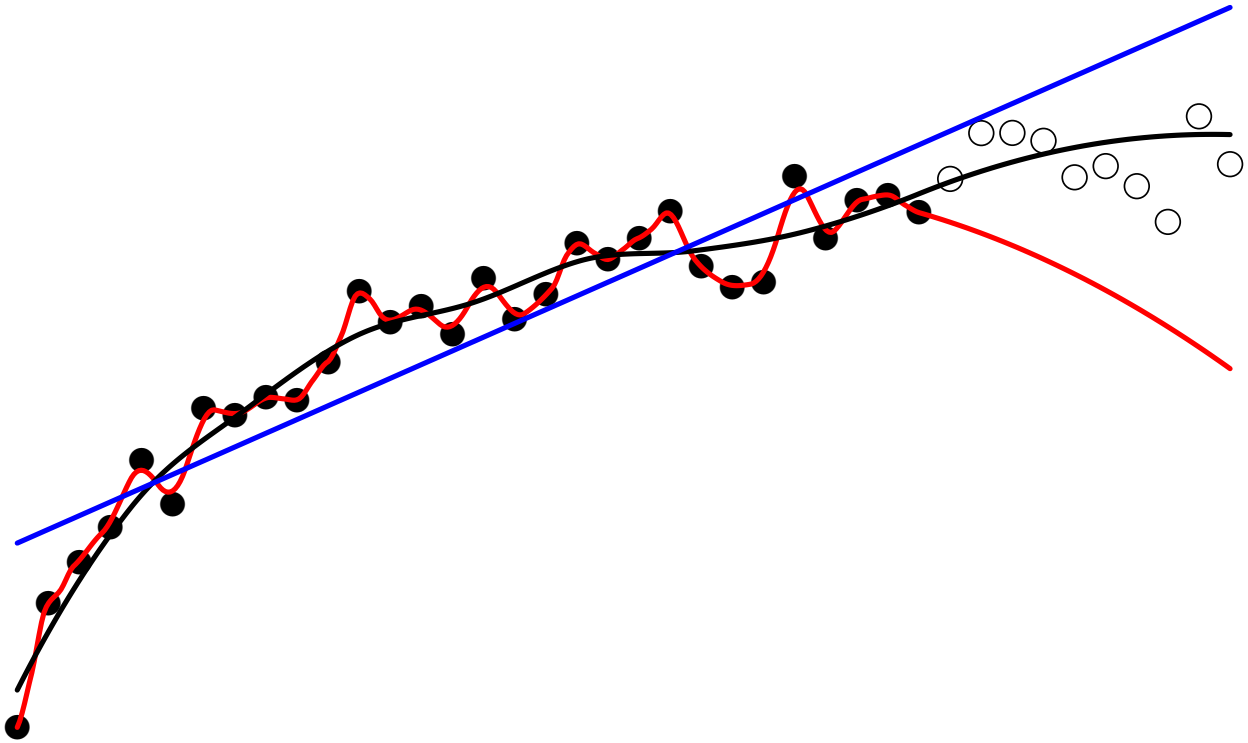
# State-space models can predict!



# We need to predict

- Too much smoothing will bias the signal
- Too little smoothing will drown the signal in noise
- Correct amount will help you look ahead



- Correct amount should not be subjective.

# Recap

## Example of SAM run with data on standard format

```
1  library(stockassessment)
2  cn<-read.ices("cn.dat")
3  cw<-read.ices("cw.dat")
4  dw<-read.ices("dw.dat")
5  lf<-read.ices("lf.dat")
6  lw<-read.ices("lw.dat")
7  mo<-read.ices("mo.dat")
8  nm<-read.ices("nm.dat")
9  pf<-read.ices("pf.dat")
10 pm<-read.ices("pm.dat")
11 sw<-read.ices("sw.dat")
12 surveys<-read.ices("survey.dat")
13
14 dat<-setup.sam.data(surveys=surveys, residual.fleet=cn, prop.mature=mo,
15                     stock.mean.weight=sw, catch.mean.weight=cw, dis.mean.weight=dw,
16                     land.mean.weight=lw, prop.f=pf, prop.m=pm, natural.mortality=nm,
17                     land.frac=lf)
18
19 conf<-loadConf(dat,"model.cfg")
20 par <- defpar(dat,conf)
21 fit <- sam.fit(dat,conf,par)
```

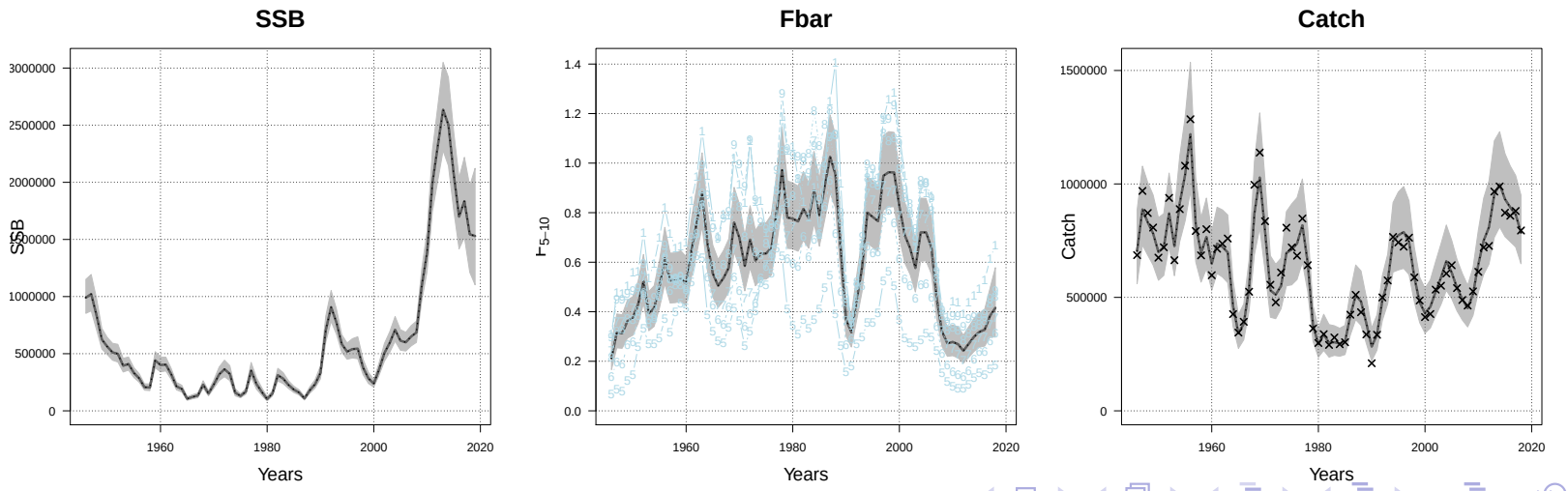
# Recap

- Configurations are modified in `model.cfg`
  - If you don't have a configurations file, create a default one:

```
conf <- defcon(dat)
saveConf(conf,file = model.cfg)
```

  - Standard graphs and tables are provided with

```
ssbplot(fit)
fbarplot(fit)
catchplot(fit)
summary(fit)
```



# What will happen next year?

- The estimated model provides information about the population dynamics
- We have an estimate (with uncertainty) about $\mathbf{N}_y$ and $\mathbf{F}_y$
- Future scenarios are predicted by simulating the future given what we think we can control

Remember we assume:

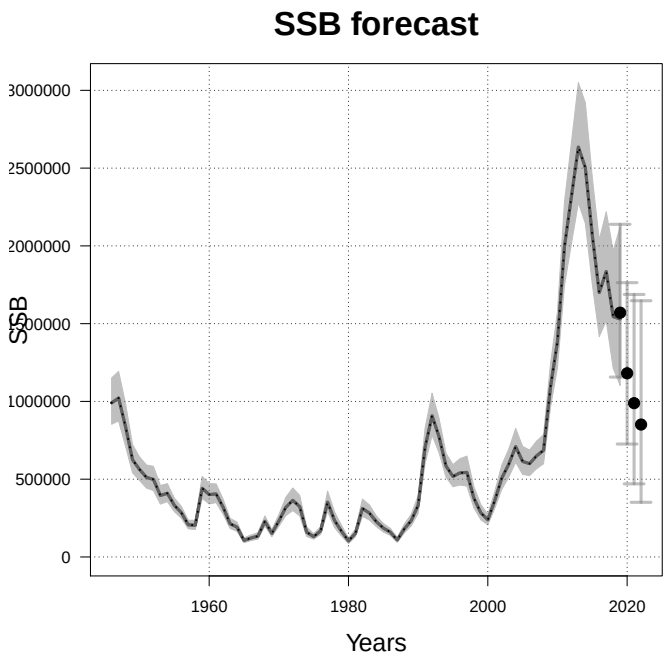
$$\log N_{1,y} = \log R(\mathbf{N}_{y-1}) + \eta_{1,y}$$
$$\log N_{a,y} = \log N_{a-1,y-1} - F_{a-1,y-1} - M_{a-1,y-1} + \eta_{a,y}$$
$$\log N_{A,y} = \log(N_{A-1,y-1} e^{-F_{A-1,y-1}-M_{A-1,y-1}} + N_{A,y-1} e^{-F_{A,y-1}-M_{A,y-1}}) + \eta_{A,y}$$

were

$$\log \mathbf{F}_y = \log \mathbf{F}_{y-1} + \xi_y.$$

# Propagating uncertainty

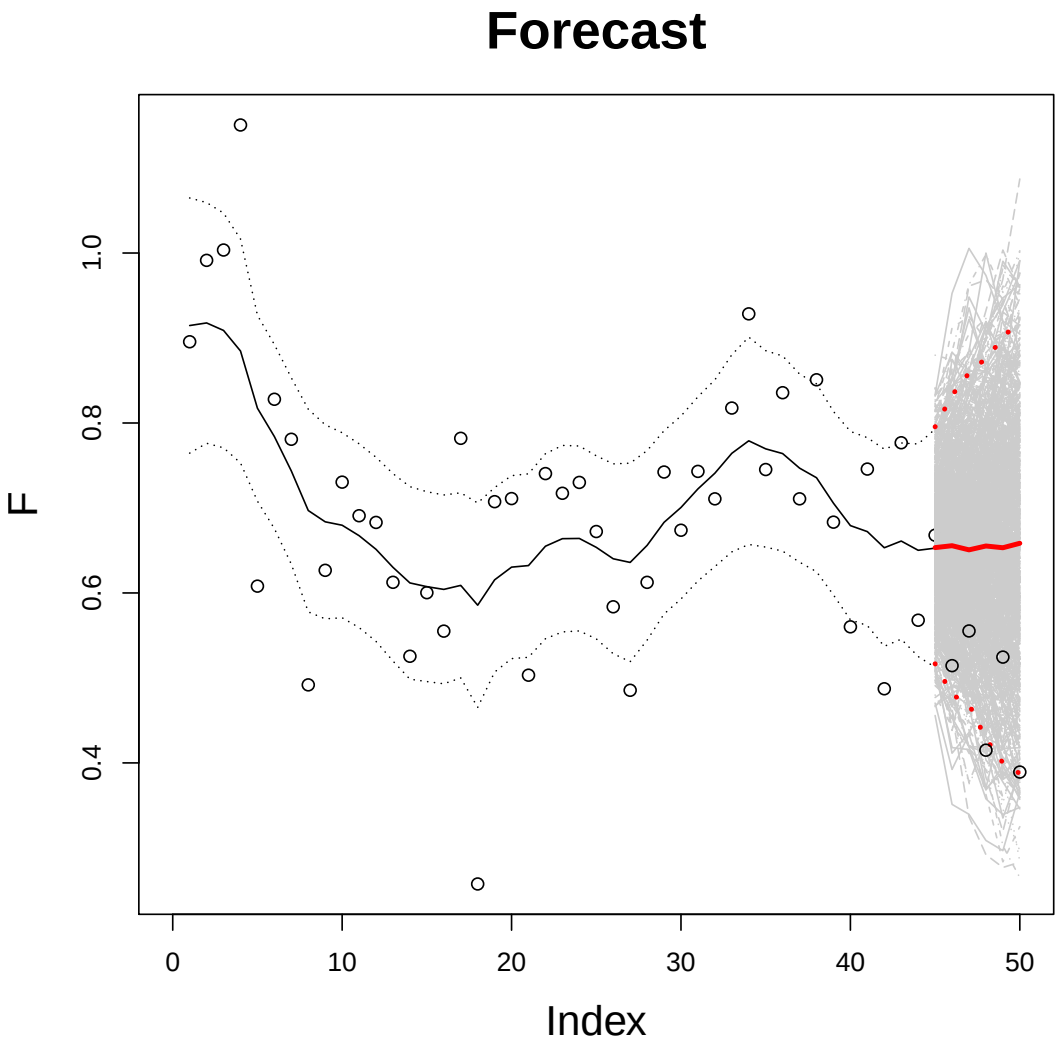
- We are uncertain about current state
- Uncertainty in current state is represented with simulation
- Simulate the process forward in time
  - We use the estimated process with noise, but fix what we think we control



# Simplest case (RW + noise)

- We will now simulate future realisations of a random walk
- Data and code provided in `rwForecast.R`, `rwForecast.cpp` and `F.RData`
- Exercise a: Estimate the model
- Exercise b: Predict future expected observations
- Future observations the next five years are provided in `futureObs` in `F.RData`

# Solution



# Does this differ from what we need?

- Higher dimension
- We typically fix one of them (e.g. catch or F)
- Otherwise it is the same thing we need to do

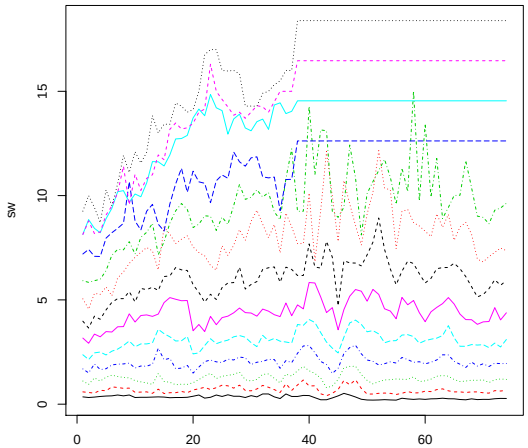
1. Simulate last state to represent uncertainty
2. Simulate forward according to model

# Predicting covariates

- Beside using the model to predict the stock, we also need:
- Stock weight, catch weights, natural mortality, maturity, ...
- They are just covariates in the model, so how do we predict them?
- Try plotting e.g. stock weights

```
1 library(stockassessment)
2 sw <- read.ices("sw.dat")
3 matplot(sw,type ="l")
```

- What is it next five years?
- Average of last (e.g. 5) years is often used.
- Research is conducted to provide a process for describing future covariates in SAM

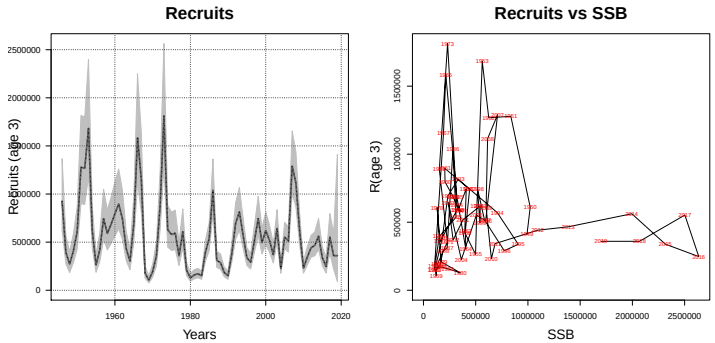


# Predicting recruitment

- This is the most difficult (weakest link)
- Most important for medium and long term forecast
- Try plotting the historical recruitment

```
1 recplot(fit)
2 srplot(fit)
```

- The model we use in assessment may not be what we want?
- Sampling from a recent period (e.g. 10 years) is often used



# The forecast function for SAM

- Start with fitting a model to get `fit`
- From (and including) last assessment year scenarios are specified
- E.g. as in :

```
1 forecast(fit,catchval = c(800000,NA,NA),fval = c(NA,0.503,NA),fscale =c(NA,NA,1))
```

- More options available available (see `?forecast`)
- Remember to mention `ave.years`, `rec.years` and `processNoiseF`

# Practical exercise

- The markdown file `NEAcod.html` illustrates the assessment for North East Arctic cod.
  - In this exercise we focus on the section `Quota advice for 2020`
- Code to fit SAM is provided in `NEAcod.R`
- Exercise: Fill inn the incomplete lines under section `Quota advice for 2020` in `codAssessment.html`
- In short we want to simulate future SSB and catches given
  - Catch in 2019 is 697 tons
  - $\bar{F} = 0.503$ in years 2020 to 2022